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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: 40 Dearborn Street, Chicago, Ill. . . CHARLES FRENCH, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

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Reports that are well authenticated indicate that the St. Louis Exposition next year will greatly exceed any former exposition in the magnitude, diversity and novelty of electrical and mechanical and allied exhibits. It is time the exposition management should commence to let the public in general, as well as electrical, know this, if the attendance the exposition will assuredly merit is to be realized.

At a recent meeting of the Maxim Electrical Engineering Company, Sir Hiram Maxim stated that he would shortly announce an important invention which will bring forth more money than anything he had ever done. Is it possible that this invention is connected with Sir Hiram's flying machine? He has made many experiments with aeroplanes and flying machines, and his papers on this subject are of great scientific value.

THE EQUIPMENT OF AN ELECTRIC CAR.

When an accident occurs on an electric car, the immediate cause of the injury or injuries is usually the panic which arises as the passengers become alarmed and rush for the doors. The mystery surrounding all things electrical to the uninformed tends to throw them into a nervous and irresponsible condition whenever anything about the car goes wrong. As a matter of fact an electric car is, compared with other vehicles, comparatively safe, and if the public could only be brought to realize this there would be fewer accidents.

The Car Equipment.

The equipment of an electric car is very simple. The truck is fitted with one or two motors which drive the wheels through gears on the axles. To control the motors there is a resistance of iron under the car body and the two controllers, one on each platform. The controllers are merely a conveniently arranged group of switches which are so designed that the proper combinations of motors and resistance are made when the controller handle is turned. The resistance is necessary to prevent the full electrical pressure from being thrown on the motors at the start, as this would tend to start them much too quickly. The other apparatus are the trolley pole and wheel, for collecting the current from the trolley wire, the circuit-breakers or automatic switches, which open and cut off the current when the motors are overloaded, the fuses which perform the same function as the circuit-breakers and which merely supplement the latter, and the lightning arrester which provides a path from the trolley wire to the rail which can be followed, easily by a lightning discharge to the wire, but which will not be taken by the current which operates the car.

In addition there is always a lighting circuit and usually a heating circuit. These run from the trolley pole to the truck and are independent of each other and of the motor circuits. The greater part of the wiring for these circuits is concealed beneath the floor of the car and is insulated.

Possible Sources of Danger.

There are two ways in which injury might be received by passengers on an electric car. Dangers due to the motion of the car are not peculiar to electrical cars and need not be considered. First, it is conceivable that due to very bad work a bare wire might be left exposed, which might cause an electrical shock, but the probability of this is so very slight that it need not be discussed. Any danger due to lightning striking the car or wire is also small. In fact, a trolley car is really a safe refuge during a storm. The other danger is that due to a fire caused by the electrical equipment.

Danger from Fire Slight.

Where the work on the car is carried out properly there

should be slight risk of fire, though, of course, electrical apparatus, as well as all other apparatus, is subject to derangement. But there is nothing inflammable about the electrical equipment, and about the only thing that can burn is the car body. There is no danger of an explosion which fills the car with flaming oil or gas, and in this respect the electrically lighted car is safer than cars lighted in other ways. Should the breakdown of the motors set fire to the floor of the car, there is little danger if only a panic can be prevented. A car body is not particularly inflammable, and there is likely to be more smoke than flame. The risk of injury from jumping from a moving car is greater.

Panics the Greatest Danger.

As has been said previously, the real danger in electric cars arises from the fact that a slight disturbance makes the passengers nervous, and a little smoke or the flash of a fuse starts a rush to the doors. The public will in time become used to the electrical methods of operation and then this danger will be less. They should expect to see a flash of light from the circuit-breaker at times and an occasional spurt of smoke when an overworked fuse melts. These effects are not signals of danger. Rather they are the signals that the safety devices of the cars are in order and are performing their proper functions.

THE MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

The fourth general meeting of the American Electrochemical Society, which was held at Niagara Falls last week, was in every way an enjoyable and profitable affair. Although the weather on the first day was bad, the bright, cheerful days following more than made up for the depression of the first.

Interesting and Valuable Papers.

At this meeting a number of papers of value and of unusual interest was read, certain of them drawing a full and illuminating discussion. A decided advantage of the meeting was the comparatively small number of papers presented. At the two meetings preceding this there were so many papers to be read that the members became wearied and attendance fell off.

The Social Side.

The social features also were enjoyable and not overdone. Each member felt free to come and go as he pleased without in any way upsetting the plans of the local committee. The meeting was certainly a decided success.

ELECTROLYSIS AND TECHNICAL COMPETENCY.

In the issue of the ELECTRICAL REVIEW for July 5, 1902, was discussed the subject of electrolysis of buried pipes, an effect which is usually attributed to the return currents from electric railways. In the discussion the following remarks were made:

The current in the pipe system can, by means of increasing the ground return, be diminished to any quantity desired, to the limit of the financial ability of the corporation controlling the situation, but it can never be reduced to zero in this way. The remedy is to break up the electric continuity of the piping system by insulating joints. A single insulating joint will stop more current in the piping system than many thousand dollars worth of copper laid in multiple with it, and twenty or thirty properly distributed insulating joints will reduce the current in a pipe line more than an almost infinite amount of copper would do.

Our contemporary, the *Electrical World and Engineer,* in its issue of July 19, 1902, took us to task for the suggestion embodied in this quotation in the editorial which we quote in part below. Our contemporary deprecated the "reopening" of the question of electrolysis from electric railway currents. In its opinion, the suggestion offered in the ELECTRICAL REVIEW was not worthy even of an attempt to show that it would be inadequate, so it assumed to maintain its authority by stating incorrectly what had been suggested and sneering at the author.

Although, in the opinion of our contemporary, the question of electrolysis was closed, since then several papers have been presented to engineering associations, both in this country and abroad, upon this topic; and one of these, read recently before the annual meeting of the German Electrochemical Society, which met in Mannheim, seemed to our contemporary to merit editorial comment. This comment, in the issue of August 29, we reproduce below in full, side by side with the quotation from the editorial of the previous year.

ELECTROLYSIS FROM ELECTRIC RAILWAY CURRENTS.

We regret to note that one of our electrical contemporaries has seen fit to reopen in a sensational manner the question of electrolysis from electric railway currents. Though the matter of corrosion by leakage from railway return currents was some years ago one of much concern, with the advance of the electric railway art and as a consequence of the thorough study given the subject by engineers, it is now known, even to the tyro in electric railway engineering, that in the relatively few cases in which injury from the corrosion of underground piping is apt to occur, a definite remedy is indicated by the local conditions. . . . The technical competency of the writer who would thus resuscitate a question that in the past has been so annoying to the electrical railway industry, may be gauged from the remedy proposed for the alleged great danger—the insulation of all joints of underground piping! And it is left an open question as to whether or not railway companies should bear the expense of applying this extraordinary remedy. It is not our custom to refer in criticism in these columns to our electrical contemporaries, but we must make an exception in this case in view of the serious damage that might be inflicted upon a great industry by such an ill-judged editorial utterance; for though none with any technical knowledge would give it a moment's consideration, the newspaper press is apt to accept the statements to which we refer as the opinion of one competent to speak on the subject, because they happened to appear in the columns of an electrical journal.—*E. W. and E., July 19, 1902.*

ELECTROLYSIS IN ELECTRIC RAILWAY RETURN CIRCUITS.

In a paper recently read before the annual meeting of the German Electrochemical Society in Mannheim, Mr. Gaisberg described the damage effected in the buried metal pipes of Hamburg by return currents from the street railway mains. It was stated that while lead pipes showed a fairly uniform oxidation, wrought iron pipes were deeply pitted in many places, while cast iron pipes were unaffected. An explanation which suggests itself for these observed conditions, is that wrought iron pipes are usually connected closely together by screw joints, and thus make good continuous metallic connection, while cast iron pipes are not usually closely united in metallic connection, and are thus electrically divided into a series of short lengths. Long conductors buried are naturally subjected to much greater danger from electrolysis than short conductors, because they serve to connect remote areas between which a considerable difference of electric potential may occur. Consequently wrought iron pipes are specially likely to carry return currents, and to be electrolytically disintegrated by them. On the other hand, when the difference of potential in the ground is sufficient to corrode cast iron pipes, the damage is apt to be more serious, since it repeats itself at every pipe joint.—*E. W. and E., August 29, 1903.*

We have not wasted any energy in an effort to bring these two quotations into harmony, but one can not help wondering where the technical competency comes in. The immunity of cast-iron pipes from electrolytic corrosion is now explained by the fact that these pipes are not usually closely united in metallic connection; but it was wicked a year ago to suggest the use of insulated joints to reduce corrosion! It speaks ill for our contemporary's opinion of the engineer, or for our contemporary itself, that it should state at one time that electrically poor joints may reduce electrolysis, and at another that none with any technical knowledge would give the insulation of joints for the purpose of reducing electrolysis "a moment's consideration."

THE PROFITABLE ELECTRIFICATION OF THE MANHATTAN ELEVATED RAILROAD.

Perhaps one of the most important and far-reaching developments of electricity is the electrification of the Manhattan Elevated Railway. It is not the intention to call attention to the great relief which has been provided to the patient travelers in the city of New York, nor of the added comfort and increased speed of the electrical elevated system. It is the financial results and the effect which these financial results will have upon the general railroad situation to which attention is called.

Successful Electrification of a Steam Road.

For many years the Manhattan Elevated Railway had been successfully operated by steam locomotives. It carried its passengers with a certain degree of comfort and speed, handling numbers greater than any other similar corporation previously, and at the same time earned dividends for its stockholders. Ever since the development of electric transportation, projects and suggestions have been made to change the Manhattan from steam locomotives to electric distribution. A conservative management, backed up by reasonably satisfied and cautious stockholders, deferred the improvement until such time as the demands of the traffic exceeded the capacity of the plant when operated by steam locomotives.

The Attitude of Steam Railroad Men.

To a certain extent this is the attitude of a great many railroad managers in the United States to-day. They recognize that their patrons would be better satisfied, and as a result they would have a larger patronage, if the heavy passenger traffic lines were operated electrically. But the large investment and the necessity of earning interest on the present capitalization and on the added cost, causes them to hesitate and wait. With this attitude of a large number of railway managers, admitting the desirability of electrification, but questioning the profit-producing capacity, the report covering the workings of the Manhattan Railway for the past year, and particularly for the last quarter of the last fiscal year, the first period of complete electrification, is of extreme importance.

In detail the comparative figures of the earnings and expenses for the quarter ending June 30, 1903, compared with the corresponding period of the previous year, are as follows:

	1903.	1902.		
Gross earnings (3 months)	$3,271,787	$2,857,250	Inc.	$414,537
Expenses	1,302,089	1,401,106	Dec.	99,017
Net earnings	$1,969,698	$1,456,144	Inc.	$513,554
Other income	90,187	111,287	Dec.	21,100
Total income	$2,059,885	$1,567,431	Inc.	$492,454
Interest and taxes	684,563	655,849	Inc.	28,714
Surplus	$1,375,322	$911,582	Inc.	$463,740

An increase in gross earnings of over $400,000 with a decrease in expenses of $99,000, making a gain to the profit account of over half a million in three months, is a strikingly pleasing and desirable result. And when the cost is figured it shows that in 1902, with steam locomotives, the cost to the company was 2.24 cents per passenger, whereas in the corresponding quarter of 1903 under complete electrification the cost per passenger was reduced to 1.98 cents. When it is noted that the diminished cost was accompanied by increased train service, increased capacity, increased speed and increased comfort to each individual passenger, the results are remarkable. Of course when analyzing the results, and even when predicting, before electrification was completed, what might be expected, many of the accomplished results were self-evident.

The Importance of This Successful Electrification.

But the important point is that this desirable result has been produced here in New York city under the direct observation of the gentlemen who control the destinies of the majority of the steam railroads of the United States. These men control the purse strings of and find money for railroad corporations when it is demonstrated to them that the proposed investment will be profitable. More than anything else, these men, these New York bankers and financiers, desire profits. They recognize that to make a railroad profitable it must satisfy the demands of its patrons and must adequately serve the territory tributary. These gentlemen, however, are loath to make large expenditures and put added burdens on corporations which under existing conditions produce reasonable profits. It is natural, especially in finance, to let well enough alone. But now managers and engineers have an illustration, both of the personal satisfaction which accrues to the passenger, as a result of the electrification of steam railroads, and also an unanswerable argument in favor of the profit-producing result from the necessary investment.

Hence it is that we say, that the great and pronounced success of the electrification on the Manhattan Railway is perhaps the most important event in the development of electric transportation. It must not be forgotten that the principal bankers in the United States, including New York banks, have refrained largely from investing in the securities of electric, or so-called trolley roads. The reasons for this disinclination may be summarized as first, the rapidity with which business has developed and the consequent uncertainty as to the future; second, the conditions, local franchises, terminable rights, etc., pertaining to most electric lines; third, the tremendous financial *optimism* evinced by most trolley road promoters. Without mentioning other reasons, these three are sufficient to account for the lack of interest in trolley securities on the part of New York bankers. On the other hand a majority, if not all New York bankers, have made the bulk of their fortunes out of steam railroads. In most instances it has been made by a general study of local conditions and predicted earnings on future development. Except in rare cases this expected development has not failed. So the situation at the present time that confronts us is that railroad managements are willing to admit the desirability of electrification, the larger railroads have ample credit or finances for at least the beginning of a comprehensive scheme for electric development, and now the last argument against the investment, that of possible failure to produce profit, is removed. We may expect to see many of the large railroads follow the lead of the Long Island Railroad Company and plan and put into service continuously increasing electrical transportation plants.

Shop Testing of Motors and Generators for Commercial Service—II.

By Bertrand B. Abry.

THE iron loss is plotted with watts as abscissæ, and generator volts as ordinates. See Fig. 3.[1] The saturation curve has for its abscissæ and ordinates, generator field current and volts.

As already mentioned, the saturation curve may start a few volts above zero, due to residual magnetism. The iron loss curve begins at zero. In general, then, we shall obtain iron loss and saturation curves as indicated in Fig. 3.

If, during the test, the excitation is carried far enough, it will be found on plotting the saturation curve that a decided bend will occur in the upper portion of the curve, indicating that the iron is becoming fully saturated. This is, of course, the so-called "knee."

3. Electromotive Force Regulation Test—The electromotive force regulation of a generator is the variation in voltage from no load to full load, the speed remaining practically constant.

For the purpose of a test, the machine may be belt-connected to a motor arranged to run at constant speed. The wiring and connections for this test are shown in Fig. 4. The load on the generator can be regulated by means of a water rheostat or any other convenient method of absorbing power. As the load is increased on the generator, it will be necessary to tighten the belt from time to time to ensure a constant generator speed. When ready to begin the test bring the generator up to speed. Then build up the generator field, adjusting the field rheostat until normal voltage on no load is obtained. Leave the rheostat at this point throughout the test. Observe the following:

Generator.			
Speed.	Amperes.	Volts.	Field Amperes.

Begin the test at zero load, increasing step by step to, say, twenty-five per cent overload.

At this point it will be well to remember that we are considering a compound-wound generator.

When the machine is tested, it is sometimes necessary to use a German silver shunt in connection with the series field. By varying the length of this shunt the field strength is decreased or increased until the desired regulation is secured. Such an adjustment provides for the proper regulation when allowance must be made for any variation in the engine speed.

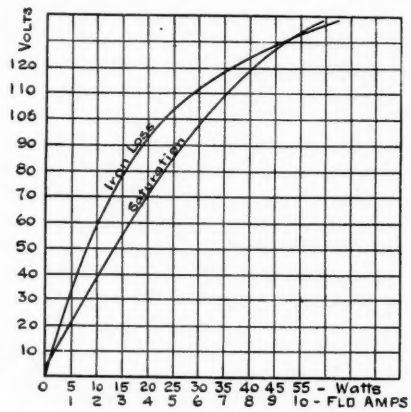


Fig. 3.—Iron Loss and Saturation Test.

Furthermore, it provides a means of increasing or decreasing the field strength due to the fact that it may be mechanically impracticable to wind the series coils of just the calculated number of turns for a given regulation. For example, the calculated series field may only require three and a fractional number of turns, but in the actual winding of the coil it may be necessary to make four complete turns. This will necessitate, then, the use of a shunt.

In a well-designed machine, after full-load conditions are reached, it will be noted that the regulation curve may become flat or possibly droop if carried farther. Likewise the field current curve. This results from the armature reaction and from the fact that any further increase in the current rapidly increases the ohmic drop and cuts down the terminal voltage. Such a decrease in the terminal voltage means a corresponding decrease in the shunt field current.

As the load is increased during the test, it should be noted whether it is necessary to shift the brushes to prevent sparking. With a well-designed machine no shifting at all or very little will suffice to insure good commutation at all loads.

In general, the regulation and field ampere curves of a compound-wound generator will appear as shown in Fig. 5. In the case of a generator these curves are plotted on an external ampere base. By "external" amperes is meant the current delivered to the line.

That automatic voltage regulation is an inherent characteristic of a compound generator, is clearly shown by the regulation curve.

A shunt-wound generator may be designed for a varying voltage with a constant load, or a constant potential with a varying load. In the latter case the results of the test should show the regulation curve a perfectly straight line. To accomplish this, hand regulation is employed, starting with the field rheostat set to give normal voltage on no load, as already explained.

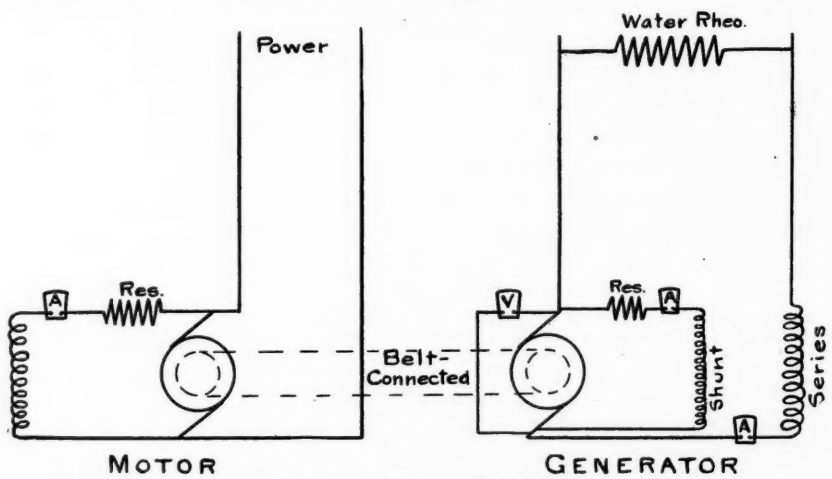


Fig. 4.—Wiring for Electromotive Force Regulation Test.

4. Calculation of Efficiency—Having determined the cold resistance, iron loss and regulation of the generator, we have sufficient data for calculating the kilowatt input and output and efficiency. The term "efficiency" is here taken to mean the "commercial efficiency" or ratio

[1] The curves shown in Figs. 3, 5 and 6 are not plotted from the performance of any machine, but merely intended to indicate the general shape and relation of such curves.

of output of generator (in watts) to the input or mechanical horse-power (in watts) delivered to the shaft. At the beginning of the tests the cold resistance of the armature, shunt and series fields and the thermometer temperatures of these various parts were determined.

For the sake of uniformity in all tests it will be found convenient to first reduce all resistances to a 100-per-cent basis, at, say, twenty-five degrees centigrade. This

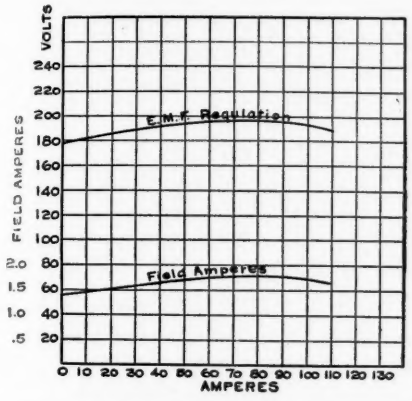


FIG. 5.—ELECTROMOTIVE-FORCE REGULATION TEST.

may be done on the assumption that an increase or decrease of one per cent from this 100-per-cent basis is equivalent to 2.5 degrees centigrade. For example, if the armature resistance as measured is .125 ohm at twenty degrees centigrade, at twenty-five degrees centigrade it will be increased two per cent and become .1275 ohm.

In calculating the efficiency of any machine intended to operate under normal conditions for a certain period each day, it would not be consistent to figure the efficiency on the basis of the cold resistances. To obtain fair results in the calculations, a resistance should be used corresponding to the temperature at which the machine is expected to run when in actual service. This may be determined by running the machine at normal load until the temperature becomes constant, and then measuring the hot resistance.

After making a great many tests on any certain class of machines, it is possible to assume a certain average per cent increase above twenty-five degrees centigrade which will closely approximate the temperature of the generator when operating under normal conditions.

If a German silver shunt is used on the machine, its resistance should also be known, but it need not be increased in the manner above mentioned, since the resistance of German silver does not change materially within the ordinary range of temperature.

After the regulation test is made, make a preliminary plot of the regulation curve and the field ampere curve, on an external ampere base, as in Fig. 5. Then, for convenience, take even values of the amperes and read off corresponding values of the voltage and field current. This voltage will be known hereafter as the terminal voltage.

Results may be tabulated as follows:

Ext. Amps.	Field Current.	Total Amps.	Term. Volts.	Total Volts.	C^2R Arm. and Ser.	C^2R Sh. and Rheo.	C^2R Brushes.	Brush Fric.	Fric. and Windage.	Iron Loss.	Total Loss.	Output.	Input.	Efficiency.

The efficiency of course is the ratio of the output and input. The input is the sum of the losses in the machine plus the output. Hence it is necessary to determine the individual losses in the generator in order to calculate the efficiency. We have already measured the iron loss, brush friction, and friction and windage. The copper losses are calculated from the resistances (corrected) and the current at different loads.

"External amperes" is the current in

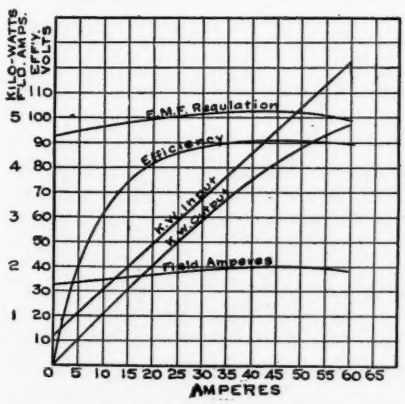


FIG. 6.—CHARACTERISTIC CURVES DIRECT-CONNECTED GENERATOR.

the external circuit, indicated by the main ammeter.

The field current column represents the shunt field amperes, indicated by the field ammeter.

"Total amperes" is, of course, the sum of the external amperes and the field current.

"Terminal volts" is the voltage at the terminals of the machine.

"Total volts" equals the sum of the terminal volts plus the drop in the machine. The drop in the machine is the sum of the drop in the brushes plus the drop in the armature and series field at the assumed average temperature. Expressed in the form of an equation, we have

Total volts = terminal volts + brush drop + total ampere X ($R_a + R_s$), where R_a and R_s are the corrected resistances of armature and series field respectively.

It is necessary to know the total volts in order to obtain the proper iron loss from the iron-loss curve.

The CR loss in the shunt field and rheostat (the latter being charged to the machine) is found by multiplying the field current by the corresponding voltage, taken from the regulation curve, for different loads.

The CR loss in the brushes is calculated from the brush cross-section and the total amperes flowing. That is, for a certain number of amperes per square inch of cross-section there will be a certain average drop. This may be taken as varying from one and one-quarter volts drop at ten amperes per square inch of brush cross-section to two and one-half volts drop at sixty amperes per square inch. (The current density should be taken to mean the amperes per square inch of brush cross-section on one side and the volts as the total volts drop per ampere on both sides.)

This average drop multiplied by the total amperes flowing will give the brush loss in watts.

Add the separate losses to obtain the total loss for the various loads at which the machine was run.

The watts output is the product of the terminal volts and external amperes. The watts input equals the sum of the total losses and the output. The ratio of the output and the input gives the efficiency.

In calculating the efficiency of any direct-current belted generator, the bearing friction and windage loss are charged to the machine. In testing an engine-type generator, the engine bearings are of course not available and the bearing friction can not be measured. In such cases the bearing friction and windage loss are charged to the engine.

A plot of the field amperes, electromotive force regulation, kilowatt input and output, and efficiency curves will appear in general as shown in Fig. 6.

These curves are plotted on an ampere

output base. The kilowatt input curve represents the sum of the losses and the output. In general, it will not vary directly with the current output, since the voltage varies more or less in all but constant-potential machines where hand regulation is employed. In the case of constant-potential machines the kilowatt input will be a straight line. Before it is possible to obtain any output the losses must be supplied, hence on an output base the kilowatt input curves cross the X-axis to the left of the origin. The difference in the ordinates of the two curves at zero amperes shows the input required to supply the losses before any power is received from the machine. The greater difference in the ordinates as the kilowatt output increases, results from the increasing losses, especially the copper loss at overloads. At zero kilowatt output the efficiency is of course zero, but rises rapidly as the load increases up to about full load. After that point is reached, it will in general begin to bend downward. This is due to the decreasing ratio of the output to the input on account of greater losses.

5. Temperature Tests—In all machines for commercial use the ultimate rise in temperature above the surrounding air when running at some definite and specified load, is an important consideration and bears a close relation to the rating of the machine. To determine this temperature rise a temperature run, so-called, is made on all generators. The machine is usually run at its full rated load until a constant temperature is reached. The length of run will depend on the size and ventilation of the machine and varies from one to fifteen or twenty hours.

The commutation should be especially noted during the test. The condition of the brushes and position of the brush-holder with respect to the neutral plane will in every case affect the commutation more or less. Before beginning any test the brushes should be properly "ground in" and the tension adjusted. The brush-holder adjustment should be such with reference to the neutral plane as to give the best commutation at all loads, but the brushes should never be shifted so far forward as to cause sparking or flashing at no load. On some machines it is possible to shift the brushes forward to a position where sparking just begins on no load and full voltage and secure besides good commutation at all loads. On other machines run at no load and full voltage it may require a forward movement of, say, five bars to obtain the first evidence of sparking; but, on the other hand, when running at full load it may only be necessary to shift the brushes forward, say, three bars to obtain good commutation. Hence in such a case it would be unnecessary to shift the brush-holder to the extreme forward position. Thus, the same rule with regard to shifting of the brushes will not apply in all cases, much depending on the voltage of the machine and the voltage between bars.

During a temperature test it is customary to make observations of the current, voltage, field volts and amperes, and the speed, at least once every hour. At the conclusion of the test thermometers are placed on the commutator, armature core and windings, and the field winding. To obtain accurate results the thermometer bulbs should be covered with a little cotton waste and left in position until a maximum temperature is recorded. This may be determined by taking readings every five or ten minutes. Knowing the maximum temperature and the air temperature, the rise in temperature for the various parts of the machine may be calculated. The cold resistances obtained in the beginning are reduced to a basis of twenty-five degrees centigrade as explained above. After the temperature run the hot resistances are measured. The rise in temperature by resistance is then calculated, on the basis of 2.5 degrees centigrade for every one per cent increase in resistance.

6. Insulation Tests—The last test made on a machine is the insulation test. This is usually made just after the temperature run while the machine is hot. The insulation of all machines will usually be weaker after their first run and while still hot than at almost any other time. If there are any weak points in the insulation they will generally show up under such conditions. The usual test on a direct-current machine is between windings and ground, and the test voltage varies from 1,200 to 3,500 volts alternating current according to the rated voltage of the machine itself. It is well to call attention to the fact that in all such tests, especially where high voltages are used, great care should be taken to protect both the operator and the apparatus from injury.

(To be continued.)

Calorie is the name given the unit of heat measurement. In chemistry the heat unit is the quantity of heat required to raise a gramme of water from zero degree centigrade (freezing point Fahrenheit) to one degree centigrade.

Recovery of Gold in Combination with Tellurium and Selenium.

In compliance with a personal letter dated June 29 from the chief of the Bureau of Foreign Commerce, asking for a special report in regard to the most effective process known and practised in Germany for recovering gold from ores containing also tellurium and selenium, Consul-General Frank H. Mason, Berlin, Germany, makes the following report:

Tellurium, which has been known as a primitive element for more than a century, and selenium, which is of more recent discovery, are distinguished in metallurgy as metals which combine chemically with gold.

The extraction of gold from telluride and selenic ores is therefore one of the most difficult problems in practical metallurgy. The discovery in recent times of extensive deposits of telluride-gold ores in Western Australia and the United States—notably at Cripple Creek, Col.—has given special importance to this subject, and it has been found on investigation that, so far as can be ascertained, the most improved and effective method known in this country is one perfected and practised by the London & Hamburg Gold Recovery Company, which has extensive reduction works at Hamburg, with offices at 20 Frauenthal in that city. This company works the telluride-selenic ores from Western Australia.

Of the process itself it has only been possible to ascertain that it is partially patented and partially held as a secret which the specifications of the patent do not disclose. What is known is that by this process telluride and selenic ores containing gold are pulverized and digested in a solution of cyanide of potash and cyanide of bromium, in proportions of seventy-five per cent of the former to twenty-five per cent of the latter. The method by which the gold is precipitated from the solution is part of the carefully guarded secret concerning which no information can be obtained, but it is certain that the process recovers ninety-five to ninety-six per cent of the gold contained in the ores, and this proportion is often as high as ninety-seven or even ninety-eight per cent.

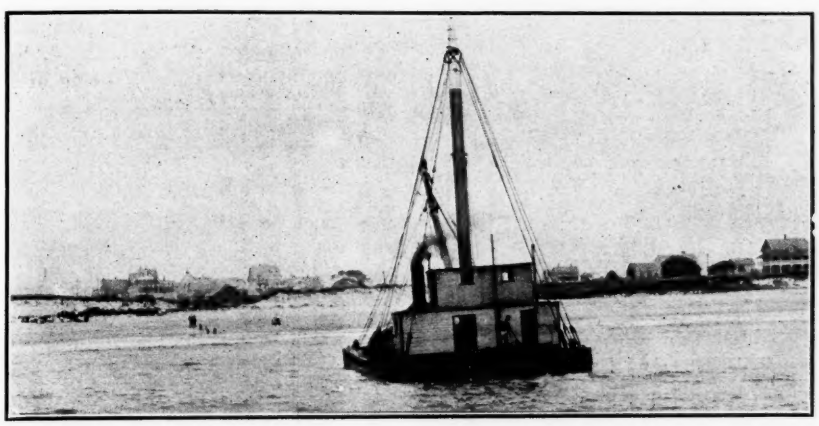
The company, while naturally refusing to disclose further details of its perfected method, will be willing at any time to make tests of American ores and give exact reports of results. Samples of ore for this purpose should contain not less than 200 pounds.

Laying the New Block Island Cable.

THE United States Weather Bureau has just finished laying a new cable connecting Block Island with the mainland at Matunuck Beach, Rhode Island. This cable is the property of the United States Weather Bureau, and will be used jointly by the telegraph service of the Weather Bureau, the Western Union Telegraph Company and the Providence Telephone Company. Telephonic communication has been cut for some time between the mainland and Block Island, but this will be resumed with the operation of the new cable.

The work was carried out under the direct supervision of Mr. Ellis B. Baker, president and general manager of the Baker Supply and Construction Company. In the party that accompanied him on the tug during the cable laying were Mr. J. H. Robinson, of Washington, D. C., chief inspector of cables for the United States Weather Bureau; Mr. George T. Manson, general superintendent of the Okonite Company; Mr. J. W. Ladd, of New Haven, superintendent of construction for the Southern New England Telephone Company, and Mr. S. B. Murray, of Brooklyn, N. Y. Mr. R. D. Blish, the cable foreman of the construction company, was on the lighter during the trip, in charge of the paying out of the cable; and Mr. H. Christian, of Newport, superintendent of construction for the Providence Telephone Company, joined the party at Matunuck Beach, where the land end of the cable was connected.

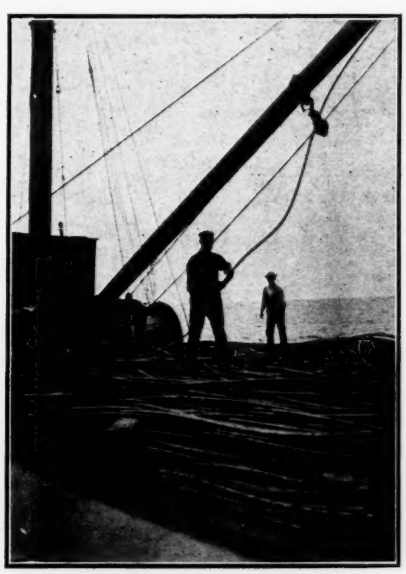
Mr. Baker and the others in his party arrived in New London early Saturday morning and were met at the wharf by the tug Alert, which took them down the harbor to the Scott company's wharf, where the lighter was tied up. Owing to the inclement weather conditions the tug and the lighter could not reach Matunuck Beach until 11.30 o'clock.



BEACHING THE LIGHTER.

PULLING THE CABLE UP THE BEACH.

The work of laying the eleven miles of heavy cable consumed rather more time than had been expected, for on the passage from the mainland to the island there was a strong head wind and head tide which made the progress of the lighter slow, and the work of getting the cable ends ashore at both terminals was cumbersome. The operation of laying the cable was done by the Baker Supply and Construction Company, of New York, for the Okonite Company, of New York, manufacturer of the cable. A tug and large lighter, and a large crew of workmen were necessary for the completion of the work. The works of the Okonite Company is at Passaic, N. J., and the cable was conveyed by flat cars from Passaic to Jersey City, where it was loaded on the lighter for transportation. The lighter, in tow of the tug Alert, left Jersey City at five o'clock on the afternoon of Thursday, September 3, arriving at New London, Conn., at eleven o'clock, Friday morning, September 4. Both tug and lighter are the property of the T. A. Scott Wrecking Company, of New London, and were chartered for the occasion by the construction company.



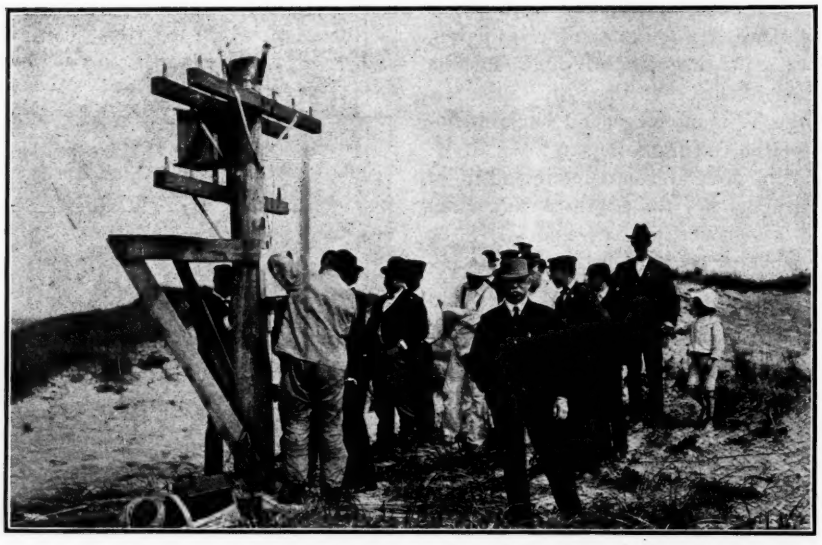
PAYING OUT THE THIRD MILE.

Landing the cable was accomplished with some difficulty, as there is considerable shoal water for a great distance from the beach, and it was with difficulty that the lighter was kept from grounding in getting it near enough to make a convenient landing of the heavy cable. However, the lighter was brought within 300 or 400 feet of the beach, and a medium-sized hawser sent ashore is a small boat. A tackle was made fast to a pole just above the beach, and the cable end secured to the hawser, when the signal was given to haul away. The point where the cable lands at Matunuck Beach is the end of a line of poles which lead down to this point just below a road which runs along the front of the beach.

Besides the regular cable force a number of the residents of the Matunuck summer colony lent their aid, and the cable was safely hauled to the pole, where it was made fast.

An iron cable box was attached to the pole, and the end of the cable brought up and wound around the pole. The

ends of the wires were then carried into the cable box and secured ready for connection with the land wires. The cable layers then returned to the tug and the lighter and prepared to start off on the run to Block Island. About two hours were spent in landing and securing the cable at Matunuck Beach, the greater part of the time being consumed in getting the lighter as near as possible to the beach.



TESTING THE CABLE AT BLOCK ISLAND.

The tug got under way with the lighter at 1.40 P. M., with the 100 tons of cable piled up in great coils on the deck of the lighter. These coils were slowly unwound and paid out over the stern as the lighter moved to the southward. The cable crew stood about and manipulated the coils so that every tangle and twist was straightened out as the cable was paid out. The cable was hauled up from the pile on the deck through two large blocks on the derrick-boom, and then passed down through a run with a brake attachment arranged at the stern, paying into the water. The weight of the cable caused it to sink beneath the surface a very few feet astern, and was all the power that was necessary to keep it uncoiling from the lighter as the vessel moved ahead.

The first mile of the cable was paid out in twenty-five minutes, the second mile in half an hour, and the third in twenty-five minutes. After the first three miles the progress was a little faster, and the ten miles to Block Island were covered in a little under four hours. The tug and lighter arrived at Sandy Point, the northernmost tip of Block Island, where the landing was to be made, at 5.30 o'clock. The landing was made in much the same manner as at Matunuck Beach, the lighter going as far in shore as was safe. The remainder of the cable was hauled ashore and work was postponed for the night, the tug and lighter putting in at New Harbor at 8.30 P. M., and landing Mr. Baker and his party. On Saturday morning the party was driven over to Sandy Point, and the crew from the lighter and the life-saving station crew pulled the cable up and made the proper connections at the Block Island cable box. There were about 300 feet left over, and this was coiled up and buried under the sand where it could be easily reached in case of further need. The three land wires were already strung as far as the beach, and the cable box and land connections were made and the cable was tested and found to be in working order.

TESTING BY TELEGRAPH AND TELEPHONE AT MATUNUCK BEACH.

The cable will be buried at each end from the cable box pole to a point beyond the low tide line.

The cable cost about $20,000, and the Providence Telephone Company will use two of the three wires by special arrangement with the government. The cable is made up of three conductors, each composed of seven strands of No. 22 copper wire twisted together and insulated with "Okonite" compound. The three covered wires are bound with jute, over which is a layer of "Manson" tape and another layer of jute. This is wound with twelve No. 3 galvanized iron wires coated with tar, then another layer of jute covered with tar on which is a covering of soapstone to facilitate handling. The diameter of the cable is one and three-quarters inches, and the total weight of the eleven miles is something over 200,000 pounds. The cable occupied six weeks in making, and the government cable inspector and the engineers of the telephone and telegraph companies were greatly pleased with its construction and manipulation.

A New Rectifier.

Messrs. Siemens Brothers & Company, of Westminster, London, S. W., England, are introducing a type of rectifier for transforming alternating into direct current. The apparatus is known as Koch's rectifier, and consists of a vibratory synchronous interrupter resembling in external appearance the polarized relay constructed for heavy currents and quick action. If a polarized interrupter is excited by an alternating current of any ordinary periodicity its armature will vibrate synchronously with the phase of the current. Owing to the self-induction of the coils of the interrupter, hysteresis of the iron and the inertia of the armature, the phase of the armature lags behind the phase of the current. Contact may, however, be rendered sparkless by putting in series with the coils of the interrupter a condenser of such capacity as not only to neutralize the self-induction of the coils, but bring the phase of the exciting current in advance of that of the main current. This counteracts the hysteresis of the iron and the inertia of the armature, and brings the latter in phase with the main current. A pulsating intermittent current is delivered, in which the makes and breaks can be made to occur at the zero points. To make the rectified current serviceable for charging accumulators, the magnets on the inter-

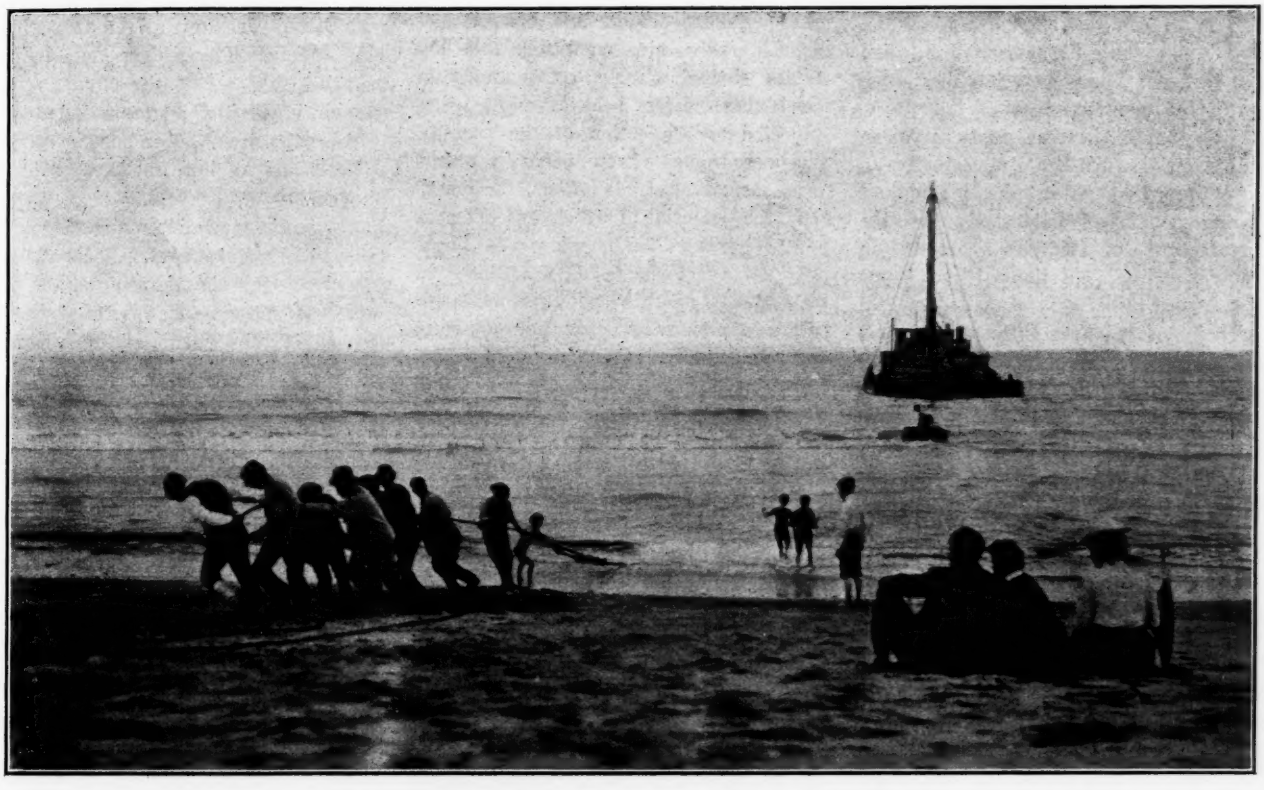
rupter must be provided with a second winding so connected to the battery that the voltage of the latter opposes the current induced by the charging impulses. If this secondary winding is properly proportioned, only the excess voltage closes the contact against the potential of the battery, and an entirely automatic adjustment of the interrupter for all battery voltages is obtained. To avoid troublesome tuning, a condenser of relatively small capacity is used, and the excessive lead is connected by placing in the circuit a coil of variable inductance. The interrupter can be made sparkless by adjusting the position of the coil of this bobbin, and it maintains its sparklessness under considerable fluctuation of potential in the alternating circuit. If the potential of the battery approximates the mean potential of the alternating current, the closed period is very short compared with the open period, and the armature has a very jerky motion, liable to cause interruptions. This is remedied by placing a choking coil to moderate the inductance between the alternator and the apparatus. This has practically no effect on the weak current flowing in the exciting circuit, but causes a displacement of the phase during the period of load, and therefore a lengthening of the charging impulses with respect to time. The efficiency of the apparatus is said to be the greater the nearer the potential of the battery equals the mean potential of the alternating current.

A Novel Generator.

According to an ingenious German invention, electricity is generated by forcing liquids, such as solutions of potassium or sodium alum, under high pressure, and at a great velocity, through magnetic fields. In the specially designed apparatus the field magnet has a single coil wound upon a cast-iron core, which is formed with a number of arms, projecting alternately from its two sides, and terminating in wrought-iron bolts, which produce magnetic fields. The bolts are supported in copper blocks, each of which has two passages opening at the front and back respectively. The solution forced in through a pipe enters the front passage in the first block and is conducted to the first magnetic field, where it cuts the lines of force at right angles, thereby generating a current which is carried off by suitably disposed copper conductors, which are all connected in series. After leaving the first magnetic field the liquid flows through an insulating grating in the frame to the next magnetic field, and so on round the machine until it leaves by a pipe. The insulating gratings are provided in order to prevent the formation of whirl currents in the frame of the apparatus.—*Kuhlow's German Trade Review, September.*

A New Form of Water Rheostat.

A convenient type of water rheostat has been designed by M. Wolliscroft, which avoids some of the inconveniences of this type of apparatus. The rheostat consists of a cast-iron drum which holds the electrolyte, the cast-iron plate swinging on insulated trunnions so that it can be lowered into or raised clear of the electrolyte. This plate is moved by a handle attached to one trunnion, and on it is mounted the open-circuit release mechanism. Within the supports of the drum is arranged an overload circuit-breaker which acts by short-circuiting the open-circuit release magnet. The movable part of the rheostat is placed so as normally to hold the circuit open. When the motor is to be started, the starting handle is pressed down, gradually releasing the resistance, until the apparatus is short-circuited automatically by a contact attached to the trunnions. In case of overload or a break in the field circuit of the motor, the releasing gear opens and the resistance is gradually increased until finally the circuit is opened.



Landing the Cable at Matunuck Beach, Rhode Island.

Cable despatches from Berlin, Germany, state that on September 18, the experimental electric car made a speed of 106 miles an hour on the Marienfelde-Zossen military railroad.

A PRACTICAL UTILIZATION OF THE PASSIVE STATE OF IRON.[1]

BY CHARLES F. BURGESS.

In what may be considered the ancient literature of electrochemistry the fact was pointed out that iron and steel may be made to assume that peculiar condition known as the passive state by employing the material as an anode in suitable electrolytes. Among such solutions are sodium nitrate and various other soluble nitrates.

Upon assuming the passive condition, the iron no longer becomes attacked by the anode products, oxygen being liberated, and the metal acting toward the solution as would an anode of platinum. While this peculiar behavior of iron, when used as an anode material, has been known for many years, it is only quite recently that it has been made use of in an industrial way.

An improvement in the method of brazing employed extensively in the manufacture of bicycles consists in dipping bodily a portion of the frame to be brazed into a bath of melted spelter, which is covered by a suitable flux. By this operation not only is the brazing effected within the joints, but a thin layer of brass adheres to the outer walls of the tubing, so that it becomes necessary to remove this layer in preparing the frames for receiving a coating of enamel.

An attempt was made to employ an electrolytic stripping process for removing this brass, but, upon trying a great many electrolytes, it was found that the iron itself tended to corrode much more readily than did the copper which enters into the constitution of the brazing spelter; and the problem resolved itself into finding a solution which would dissolve the copper, but in which the iron would not corrode.

Iron has a position considerably above copper in the electrochemical series of elements, and where two different metals are in contact the natural tendency is for the more electropositive one to go into solution with the greater ease. The idea presented itself of making the iron more electronegative than the copper by causing it to assume the passive state, and upon using the sodium nitrate solution in which this state could be developed it was found that the brass could be completely removed and the iron left intact.

This method of electrolytic stripping was installed and operated with success in various factories, and is now an important adjunct to the dip-brazing method. This same electrolytic stripping process may be applied equally well in removing silver, lead, tin and other metals more electronegative than iron from an iron surface. Nickel can not be removed in this way, however, since nickel, as well as the iron, assumes the electronegative or passive state.

In some correspondence with the Patent Office it was claimed that while the iron might assume a passive condition, becoming coated with a resistant film of iron oxide, it could not be considered as becoming electronegative. For the purpose of determining this question, some measurements of single potentials were made upon iron before and after it had assumed its passive condition, and the results showed clearly the manner in which these metals behaved while being subjected to the action of the current. The measurements were made by means of a normal electrode of the "calomel" type, the potential of which was taken as — 0.56 volt. The metal whose single potential was to be tested was placed in the electrolyte and the potential measured before applying an electrical pressure, and also after currents of different values had been caused to flow. It was found that up to a certain limit the single potential varied in accordance with the current density. These values at different current densities were determined by a specially constructed switch, which broke the current and immediately connected the electrode with the normal electrode circuit for an instant, long enough to determine the direction of the movement of the meniscus of a capillary electrometer used as a zero potentiometer instrument.

It was noted that the single potential of iron immersed in a sodium nitrate solution before the current passed was in the neighborhood of + 0.2 volt. In other words, a potential was set up toward the solution in the same direction, but of less magnitude than would be produced by zinc. By causing the current to pass from the iron electrode, however, this potential quickly became negative, and increased rapidly in negative value until potential as high as — 2 volts could be obtained under certain conditions. This potential of iron, when in the passive condition, is considerably higher than the single potential of platinum, and consequently in this condition may be considered as electronegative to that metal. Its potential is approximately equal to that of the peroxide plate of the lead storage battery.

Copper, on the other hand, does not change its contact electromotive force in anywhere near the same degree. The maximum electromotive force of copper was — 0.65 volt, and iron may readily be made much more electronegative than this value.

It was found that the iron did not assume the passive condition when used in sodium nitrate solution freshly prepared, but that this condition was developed after the current had flowed for some time. This fact led to the conclusion that the solution underwent some chemical change which was favorable to the passive state.

In removing brass from iron, the current should remove it at the approximate rate of one gramme per ampere-hour, provided that all of the current enters the solution from the brass and none of it utilizes the iron as an anode surface. A brass and an iron anode, each having dimensions of 1 by 2.75 inches, were immersed in a sodium nitrate solution to test the requirement. Each was connected through the ammeter to the same source of current. It was found that on first closing the circuit almost all of the current passed through the iron anode, but after operating for a few seconds the iron became passive, after which the brass took all of the current, the amount passing through ammeter being so small as to be hardly detected. By using very high-current densities, however, the iron may begin to conduct a small portion of the current, thus causing a liberation of oxygen on the iron surface. From these tests it was shown that the current has a high efficiency in the removal of the brass, and a practical trial has demonstrated that a small percentage only is wasted by flowing from the iron surface, provided the solution be maintained in good working condition and the applied electrical pressure be kept within suitable limits.

[1] Abstract of a paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 18, 1903.

Nitrates by Electricity.

There is now being made in the Canton Vaud an interesting attempt to utilize the nitrogen of the air for purposes of industry and commerce. Electricity is the active agent in the new process, of which the inventor is M. Ami Chessex, and the shareholders of the Motor Power Company, of the Grande Eaw, have, it is stated, ratified a contract with the Nitric Acid Manufacturing Company, of Fribourg, for the experimental manufacture of nitric acid under practical conditions by the process.

ELECTROLYTIC COPPER REFINING.[1]

BY WILDER D. BANCROFT.

In determining the best conditions for the electrolytic refining of copper, we must consider the cost of the power necessary to precipitate a tank-full of copper under different current densities and at different temperatures; the cost of heating the tank; the deterioration of the electrolyte; the interest charge on the copper in the tank; the cost of pumping, and the quality of the copper deposited. Good adherent copper can be obtained at almost any current density, provided the rate of circulation be sufficient. The question of the cost of pumping has not been taken up, and is supposed to remain constant while the conditions are varied. The watt-hours necessary to precipitate a gramme of copper increase with increasing current density, and decrease with rising temperature. The cost of heating increases with rising temperature, and the interest charge on the copper in the tank decreases with increasing current density. With increasing current density, we have to strike a balance between the increasing power and the decreasing interest charge. With rising temperature, we have to strike a balance between the decreasing cost of power and the increasing cost of heating. The object of this paper is to furnish data bearing on these points. Two of my students, Messrs. Schwab and Baum, have heretofore determined the relation between voltage, current density and temperature for pure copper plates set a definite distance apart in four solutions. By expressing the voltages in terms of the voltage at twenty degrees, the effect of the distance between the plates is eliminated, and the percentage variations hold for any set of plates in the same solution. Data have been obtained showing the relations between current efficiency, current density and temperature for pure copper plates in four different solutions. These experiments were necessary because Foerster and Seidel[2] had found a marked falling off of the current efficiency above fifty degrees. These runs also give the degree of neutralization of the acid by copper. Incidentally, some experiments have been made on the effect of iron salts. The cost of heating tanks similar to those used by the Baltimore Copper Company has been determined, and Messrs. Schwag and Baum have calculated the variation of the cost with varying conditions of temperature and current density for the case of all power costing at the rate of $20 per horse-power-year, and for the case in which steam heating costs only one-thirtieth of electrical heating.

[1] Abstract of a paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 18, 1903.

[2] Zeit. anorg. Chem. 14, 188 (1897).

TEST NO. 1.

The object of this test was to determine the variation of voltage with variation of temperature, current density and solution. In commercial copper refining two standard solutions are used, each solution containing sixteen per cent copper sulphate crystals. The refineries using the Hayden system make up their electrolyte to contain also six per cent sulphuric acid, while the plants operating with the multiple system use a nine per cent acid solution. It has been claimed that the addition of a small quantity of sodium chloride produces a more coherent form of copper at the higher current densities. Experiments were therefore made with the following solutions:

SOLUTION A.

16 per cent $CuSO_4 5H_2O$ and 9 per cent sulphuric acid.

SOLUTION B.

16 per cent $CuSO_4 5H_2O$ and 6 per cent sulphuric acid.

SOLUTION C.

Solution A + sodium chloride (1 : 2,000,000 of solution).

SOLUTION D.

Solution B + sodium chloride (1 : 2,000,000 of solution).

Pure copper plates, five centimetres wide and dipping ten centimetres into the solution, were used as electrodes, one cathode and two anodes. The plates were held one centimetre apart, and arrangements were made for efficient stirring. The four solutions were placed in four beakers, and the measurements made under practically the same conditions by means of Weston instruments which had been compared with a standard. The four beakers stood in a large water bath.

The voltage required to obtain a given current density is materially less with the nine per cent acid solution than with the six per cent acid solution. The addition of sodium chloride to the solution increases the voltage at the lower temperatures, while the effect is scarcely noticeable at the higher temperatures.

TEST NO. 2—CURRENT EFFICIENCY RUN.

The object of this test was to determine the variations of the current efficiency when operating with the different electrolytic solutions at varying temperatures and different current densities. Heretofore it has been claimed that the current efficiency drops off rapidly when working at temperatures above fifty degrees centigrade. It was to verify the correctness or prove the incorrectness of this claim that this test was made.

The apparatus used in this test was practically the same as was used in the voltage test (test No. 1), with the addition of a copper voltameter run in series with the four other cells.

The electrolytes used for this run were the same as those of the voltage run, *viz.*: Solutions A, B, C and D.

This test showed that the current efficiencies for temperatures below seventy degrees centigrade fall off but very little, and are practically 100 per cent. Even at a temperature of ninety degrees centigrade and a high current density of four amp/qdm, the efficiency runs as high as ninety-eight per cent and ninety-nine per cent for the nine per cent and six per cent solutions, respectively, while a current density of one amp/qdm gives an efficiency of ninety per cent and ninety-one per cent.[1] Between fifty and seventy degrees, the efficiency in some cases runs a trifle above 100 per cent. This is no doubt due to the formation of cuprous sulphate in small quantities in the electrolyte.

The deterioration of solution is proportional to the ratio of anode loss to cathode gain, since pure copper plates were used and there was no sediment or copper scrap on the bottom of the beakers. The solution deteriorates more rapidly at the higher temperatures and at the lower current densities. This deterioration of solution probably more than offsets the advantage of decrease in voltage which the higher temperatures give, but only when operating at the lower current densities. The ratio of anode loss to cathode gain, when operating at seventy degrees centigrade and four amp/qdm, is hardly any higher than this ratio for operating temperatures between twenty degrees and fifty degrees.

EFFECT OF IRON IN ELECTROLYTE.

Frequent statements have been made that the presence of iron in the electrolytic solutions cuts down the current efficiency. To investigate this, solutions containing iron were electrolyzed between

[1] While this result is apparently in flat contradiction with that of Foerster and Seidel, this is not really the case. These authors find forty-seven per cent efficiency with 0.3 amp/qdm and eighty-three per cent efficiency with one amp/qdm at 100 degrees, while we find, at ninety degrees, ninety-one per cent efficiency with one amp/qdm and ninety-nine per cent efficiency with four amp/qdm. The highest current density of Foerster and Seidel is our lowest. Since no refinery in this country runs at as low a current density as one amp/qdm (except perhaps the Calumet and Hecla), the conclusions of Foerster and Seidel are not applicable to American practice.

weighed copper electrodes at a temperature of forty-five degrees centigrade and a current density of two amp/qdm, with a voltameter in series. The results obtained show that there is no falling off in the current efficiency. After the test the precipitate on the cathode was dissolved in nitric acid, and the solution was tested for iron. None was found, thus demonstrating that iron was not precipitated from the solution.

TEST NO. 3—RADIATION RUN.

One of the important items in electrolytic copper refining is the cost of maintaining the electrolytes in the vats at operating temperature. To form some idea of the relative costs of operating at various temperatures was the object of this test.

The vats in a plant using the Hayden system are nine feet long, two feet wide and two and one-half feet deep, and are filled with copper plates one-half inch apart. Accordingly, there was constructed a small tank out of one-half-inch stock, with the inside dimensions of nine by two by two and one-half inches, and filled it with copper plates one-half inch apart. The joints of the tank, as well as the inside, were lined with tar, thus effectually preventing leaks.

As a means of heating up the tank, a platinum coil was placed on the bottom, and connections brought out to binding-posts on the sides of the tank. Next the tank was filled up with electrolytic solution (solution A), and its temperature brought up to near the boiling point by passing an alternating current through the platinum coil. When the solution had reached a temperature of about ninety-five degrees centigrade the current was turned off and the run started.

A standard thermometer was placed in the electrolyte, and readings of its temperature taken at varying intervals of time, until the temperature had dropped to about forty degrees centigrade. Two radiation runs of this sort were made—the first with the tank uncovered, and the second with a cover over the top.

The tank was again heated up to ninety degrees centigrade, and the current so adjusted that the temperature of the solution was maintained constant. The power required to overcome radiation at ninety degrees was determined both for covered and uncovered tanks. The power required at several different temperatures was computed for both covered and uncovered tanks, and the data are given in the following table.

CONSTANT TEMPERATURES—POWER DATA.

Tank Covered.				Tank Uncovered.			
Temperature Degrees.	Watts.	Temperature Degrees.	Watts.	Temperature Degrees.	Watts.	Temperature Degrees.	Watts.
90	44.0	65	25.2	90	145.0	65	42.0
85	40.1	60	21.7	85	118.0	60	34.4
80	36.6	55	18.8	80	90.4	55	26.4
75	33.5	50	14.5	75	67.3	50	20.6
70	28.8	..	....	70	50.6	..	....

Since the radiation of any two similar bodies is directly proportional to the area of their radiating surfaces, these values of power as determined for the small tank can be easily translated to figures for a tank of commercial size by multiplying by 100.

COMMERCIAL TEST.

In this test an attempt was made to duplicate commercial conditions in the precipitation of electrolytic copper. Through the courtesy of the Baltimore Copper Company several hundred pounds of their commercial anode plates were obtained.

As the current efficiency could not be computed from the results of this run on account of a short-circuit which occurred, an extra determination was made with a commercial anode, using the current-efficiency apparatus previously described. This run was made at forty-five degrees centigrade and a current density of two amp/qdm. From the current efficiency obtained, it is clear that the impurities in the anode do not cut down the current efficiency to any great extent. The current efficiency of commercial tanks does not reach this high figure, probably due to leakage of the current through the slimes on the bottom.

CALCULATIONS FOR COST OF REFINING.

Basis—One tank, inside dimensions two by two and one-half by nine feet. Outside dimensions taken as 29 by 34 by 16,000 square inches. Ratio of radiating surface of small experimental tank to commercial tank is about 1 to 100.

SOLUTION D.

The basis for the following figures on the cost of production are as follows:

One tank, containing 130 electrodes of two plates each.

Weight of copper per tank = 5,700 pounds.

Value of copper per tank = $800.

Cost of power = $20 per horse-power year.

Plant temperature = twenty degrees centigrade.

The calculation is made on the basis that the heating of the electrolyte is done by means of the electric current. In such cases, where the cost of heating the solution is greater than the cost of precipitating the copper, we have taken as the figures of cost the former, and *vice versa*, since, in precipitating the copper, the energy is consumed simply in overcoming the resistance of the electrolyte, and thereby heating it. The following table gives the results of the calculations.

COST OF REFINING TANK OF COPPER.

Amp/qdm.	Temperature Degrees.	K. W.-Hours to Deposit.	Cost to Deposit.	K. W.-Hours to Heat.	Cost to Heat.	Interest on Copper.	Total Cost.
1	20	390	$1.195	000	$0.00	$2.975	$4.17
1	50	196	0.601	793	2.425	2.975	5.40
1	70	153	0.468	1,550	4.755	2.975	7.73
1	90	134	0.411	2,360	7.205	2.975	10.18
2	20	608	1.86	000	0.00	1.487	3.35
2	50	362	1.11	396	1.21	1.487	2.70
2	70	274	0.84	775	2.38	1.487	3.87
2	90	233	0.71	1,180	3.60	1.487	5.09
3	20	795	2.43	000	0.00	0.99	3.42
3	50	519	1.59	264	0.81	0.99	2.58
3	70	400	1.22	517	1.58	0.99	2.57
3	90	341	1.04	787	2.40	0.99	3.39
4	20	1,000	3.06	000	0.00	0.74	3.80
4	50	647	1.98	198	0.61	0.74	2.72
4	70	519	1.59	388	1.19	0.74	2.33
4	90	433	1.33	590	1.80	0.74	2.54

While these figures are based on experiments with the series system, it is probable that the conclusions to be drawn would apply equally well to the multiple system.

Exception may be taken to these estimates of the cost on the ground that, in practice, the solutions are heated by

steam coils, and that this costs less than electrical heating. To meet this objection, the results have been calculated on the basis of electrical power at $20 per horse-power-year, and steam heating at one-thirtieth the price of electrical heating. The data for the two calculations are given in the table, and show cost per ton of copper instead of per tank.

COST PER TON OF COPPER.

Amp/qdm.	Temperature Degrees.	Cost 20—20.	Cost 20/30.
1	20	$1.46	$1.46
1	50	1.89	1.28
1	70	2.78	1.25
1	90	3.57	1.27
2	20	1.17	1.17
2	50	0.95	0.91
2	70	1.36	0.83
2	90	1.79	0.80
3	20	1.20	1.20
3	50	0.91	0.91
3	70	0.90	0 78
3	90	1.19	0.72
4	20	1.33	1.33
4	50	0.95	0.95
4	70	0.82	0.82
4	90	0.89	0.89

It must be kept in mind that these estimated costs do not include the cost of labor, and are based on the assumption of 100 per cent current efficiency.

CONCLUSION.

Summing up the results obtained for the different runs, it is now possible to draw conclusions as to what are the most financially economical conditions under which to refine copper electrolytically.

Two sets of curves were plotted, one showing the relation between the cost to precipitate a ton of copper and the operating temperature, the second set showing the relation between the cost to precipitate a ton of copper and the operating current density. From these curves, it is evident that to operate at a temperature of ninety degrees and a low-current density is entirely out of the question, not only on account of the cost of power to heat the solution and precipitate the copper, but also on account of the deterioration of solution, which takes place very rapidly under these conditions. At this high temperature and the higher current densities, the cost rapidly approaches a minimum, but here also the deterioration probably more than offsets the advantage of reduced cost of power. To operate at twenty degrees centigrade is not so costly as would seem at first thought. The cost is maximum at the lowest and the highest current densities, reaching a minimum between two and one-quarter and two and one-half amp/qdm.

At fifty degrees it would not be economical to operate at one amp/qdm, but the cost drops off very rapidly between one and two amperes. At the higher current densities the cost fluctuates but very little, reaching a minimum at about two and one-half amp/qdm.

The result at seventy degrees seems the most satisfactory, and it is at this temperature that we shall get the best results. Although the cost runs very high at this temperature for a current density of one amp/qdm, it begins to drop off very rapidly as the current density increases, until it assumes a practically constant value at the higher current densities. Between 3.5 and 3.75 amp/qdm would be the best current density for obtaining economical results, for at this density no extra power would be required to heat the solution. Operating at this current density, and with the tanks covered, the current alone would be sufficient to heat the electrolyte to over eighty degrees. In order to secure a good circulation, essential for a good deposit with high-current densities, the present method of pumping could be retained.

The lower the cost of heating, the greater the advantage of a high temperature. Lowering the rate of interest decreases the advantage of a high-current density. With covered tanks, it will be possible for men to work in the tank room even with the electrolyte at seventy degrees.

If we compare the cost of working under so-called standard conditions of open tanks, a current density of fourteen amp/sq ft and a temperature of fifty degrees with the cost of working with covered tanks at seventy degrees and a current density of 3.5 amp/qdm (31.5 amp/sq ft), the saving by the latter method will be very close to a dollar a ton of refined copper when all power is figured at $20 per horse-power-year.

Therefore, in order to operate a plant most economically, copper should be refined electrolytically under these conditions:

1. Covered tanks.
2. Current density 3.5 amp/qdm.
3. Temperature seventy degrees.

The Zambesi Power Scheme.

The African Concessions Syndicate, which was organized to exploit the possibilities of the Victoria Falls, on the Zambesi, has issued a report describing the work so far accomplished. These falls are over 400 feet high, and their power is estimated at 35,000,000 in the wet season, while that of Niagara is 7,000,000 horse-power. The railway has now been completed to within seventy miles of the falls, and will reach them before the end of next March. It is believed that it will be practicable to carry the electrical energy generated at the falls economically as far as the Rand, and it is hoped to work by means of it a large portion of the South African railway mileage, as well as to supply the power in the gold mines. American estimates are that with conditions similar to those in Rhodesia it will be possible to convey the current 330 miles and deliver it there at a cost of $22 per kilowatt per year, the load being on the whole twenty-four hours of the day. Within a radius of 300 miles of the falls there are important gold fields, coal fields, copper fields and about 900 miles of railways, while a transmission of 600 miles would take in the whole of the South African gold fields. The site of the falls is said to be healthy throughout the year, and the whole region is thought to be more richly endowed in mineral wealth, including copper, iron, gold and coal, than any similar area on the surface of the globe. At present only preliminary survey work is in progress, but it is expected to complete this very shortly, and work will then be begun on the building of a hydroelectric generating station much on the lines of that at Niagara Falls.

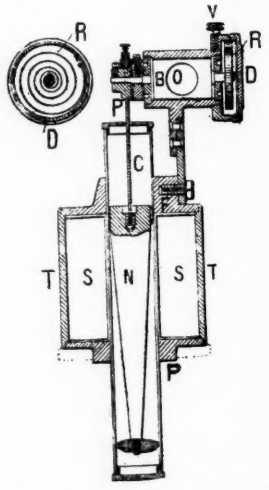
Sir Hiram Maxim Announces a New Invention.

Sir Hiram Maxim stated at a meeting of the Maxim Electrical and Engineering Company, of London, on September 14, that he will shortly announce an important invention which will bring forth more money than anything he has ever done, not excepting his automatic gun. He added that he was putting thousands of pounds into the invention, the character of which he will not divulge until all the patents are secured. The president of the company announced that the company had the patent for a new boiler, made entirely of steel, which was more economical in working and cheaper than anything of the kind now on the market.

Electrical Notes from Europe.

From Our Special Correspondent.

THE De Dion Company, of Paris, has recently brought out a compact generating set which consists of a petrol motor of its standard type with some slight modifications, and direct-coupled to a small four-pole dynamo of five kilowatts. The motor makes 1,500 revolutions per minute and is almost entirely enclosed by the field casting. One of the principal novelties of this apparatus is a new electromagnetic regulator which is operated by the main circuit and acts upon the supply valve of the petrol motor. It varies the motor speed at each instant so as to give a constant voltage at the dynamo terminals under varing loads. The use of a regulator upon the petrol motor dispenses with a rheostat or compound winding. This device, which is shown in the diagram, consists of a solenoid S which acts upon a core N of conical form. The core works up and down inside of a tube which serves as a guide. To provide a stronger field with a given current, the magnetic circuit is closed by the soft iron end-pieces FF and the outer tube T around the solenoid. This arrangement also protects the device from the influence of the surrounding field. The upper end of the solenoid is attached by a chain C and a pulley P to the end of the revolving valve B which is fixed on the carbureter of the motor. The opening O of the valve is placed in the passage which brings the explosive mixture from the carbureter to the motor. Under these conditions the movement of rotation which is communicated to the pulley P by the core N will have the effect of closing more or less the passage of gas to the motor. A spiral spring R, mounted on the other side of the revolving valve, is fixed at its outer end to a screw-cap D so that the tension of the spring can be regulated by turning the cap, thus changing the sensitiveness of the regulator. The ends of the solenoid are connected to the main terminals of the dynamo which is shunt wound. When the motor starts the dynamo becomes excited and the voltage soon comes up to the normal value. If there is no load on the dynamo the motor will tend to race, but as soon as the normal voltage is exceeded, the core N of the solenoid is pulled down and by its action on the pulley it closes more or less the valve which supplies the motor, thus reducing its speed until the voltage of the dynamo resumes its normal value. When a load is thrown on the dynamo the speed of the petrol motor tends to slacken up and the voltage is lowered. In this case the core rises and allows the spring R to open the admission valve and increase the motor speed. In practice the electric governor follows all the variations of load and the voltage always remains constant. Its action is very rapid and the regulation is made in less than five seconds in passing suddenly from no load to full load or *vice versa*. The variations of voltage are kept below three volts. As to the energy which is consumed by the governor, it is stated to be about five watts and is thus almost negligible. The



De Dion Generating Set Voltage Regulator.

new group is especially adapted for charging storage batteries, as there is no danger from a varying voltage and the battery can not be deteriorated by an overcharge or a too heavy current. It is only necessary to regulate the governor once for all to suit the given case.

One of the questions which was considered by the last automobile congress held at Paris was the standardizing of accumulator cells for electromobiles and also those which are used for producing the ignition spark for the petrol motors of automobiles. The congress appointed a committee of leading scientists and engineers as well as automobile constructors, who are to consider the question and make a report in October. The committee find that at least two dimensions of the cell can be standardized, namely, the width and the height, which correspond with the dimensions of the plate, while the length corresponding to the number of plates will doubtless remain variable. In this way all the accumulator boxes for electromobiles will have the same height and width and only the length will vary. The size of plate which seems best adapted for the purpose and is proposed by the committee is 112 millimetres wide and 270 millimetres high. The want of a standard accumulator cell has long been felt and it will be of great convenience. Another question which was taken up by the committee relates to the small accumulators for use with gasoline motors. A few years ago nearly all the makers constructed these cells on a uniform size, but at present there is but little uniformity, especially as a smaller type of cells had to be made for the new motor-bicycles. It is now proposed to standardize this type of accumulator cell and to use the standard plate of 112 millimetres wide, which will be cut down in length so as to make a smaller cell for the igniters. In this case the cell, which will be made of celluloid or similar material, will be 107 millimetres long and eighty millimetres wide. For motor-bicycles the cells will be made just half of the former size so that two of them, side by side, will occupy the standard space. It is also proposed to standardize the screw-threads of sparking plugs so that these will always be interchangeable. This will be easier to carry out, as at present nearly all the constructors use a uniform screw-thread which is that of the De Dion plug, having a diameter of eighteen millimetres with a pitch of 1.5. Another piece to be standardized is the contact plug for charging automobile batteries, so that vehicles can fit their plugs into any charging station which is found en route. At present the plugs have different forms. Some have two separate plugs and in others the two are united by an insulating cross-piece and have different diameters so as not to invert the poles. A very good form which was presented to the congress is that of two concentric pieces which fit into a single socket, and it is proposed to adopt it as standard. This form is now made by the Clemançon company. It has an interior cylinder corresponding to the positive pole, surrounded by a brass tube for the negative. The plug thus formed is provided with a two-strand cable, at present made in two sizes for thirty and fifty amperes.

The two sets of storage battery

which have been lately installed by the Edison Company, of Milan, are no doubt the largest batteries in Europe. The first battery, which is used for the tramway system, consists of 260 cells of the Tudor pattern, giving 3,500 amperes on an hour's discharge or 6,000 amperes on a short discharge. The cells in working order weigh 4,840 pounds each and are made up of twelve positive and thirteen negative plates. They measure eight feet four inches long, thirty-two inches wide and forty-one inches high. The battery is disposed in six rows of cells, using copper connectors of twenty-five square centimetres section. It is designed as a reserve in case the generating station of Paderno should cease to work, and can furnish 2,000 kilowatts for one hour. During this time it can operate the whole of the Milan tramway system, which uses 300 cars. The second battery is used for the lighting circuit in parallel with the dynamos. It contains four series of seventy-eight cells, or 312 in all. The cells are of the same size as the former, but each contains thirty-three plates instead of twenty-five. The battery will give a discharge of 20,000 amperes during one hour. Under ordinary circumstances its power is rated at 3,000 kilowatts, but it will give as high as 4,000 kilowatts on a short discharge.

An interesting experiment on the use of graphite in connection with oil for lubricating machines has been carried out in Germany. The addition of a small amount of graphite to the oil seems to be a decided advantage. The experiments were carried out upon locomotives of the Saxony railroads. The usual lubricating oil was mixed with a small percentage of a very pure graphite in the form of small and very thin scales. In the case of journal boxes, these were filled up with waste which had been saturated with the mixture of oil and graphite and also with a little tallow, and the waste was strongly compressed upon the journals. In the case of oilers for other parts of the mechanism, they are filled with the oil and graphite mixture. The consumption of graphite is very small, only 200 grammes for a run of 5,000 miles. The experiments have proved so successful that it is now proposed to use the mixture exclusively. Where ordinary lubricating oil is used at the rate of twenty-two grammes per kilometre the new mixture requires only ten grammes.

The Italian Government is now maturing the extensive wireless telegraphy projects which were mentioned in a recent note. Upon consultation with Signor Marconi it has been decided to proceed with the construction of fourteen wireless telegraphy stations at different points of the peninsula and also in Sicily and Sardinia. These stations will practically cover the whole country. The three stations which now exist comprise that of Mt. Mario, near Rome, a station on the Island of Palmaria, opposite the Gulf of Spezzia, and the Maddalena station in Sardinia. Of the fourteen new stations which are to complete the Italian system, may be mentioned that of Cape Mele, near Genoa, one on the Island of Ponza, opposite the port of Gaëta. An important post will be erected on the Island of Pantelleria which will cover the strait between Sicily and the north coast of Africa, connecting the eastern and western parts of the Mediterranean. This station can thus easily communicate with the African coast. The Island of St. Antioco will have a station at its southern point, the Cape of Sperone, while two others will be placed on Cape Spartivento and Cape Carbonara. On the east coast there will be a station near Venice, at the hido, and another at Mt. Cornaro, near Ancona. The Island of Sardinia is to be covered by four stations. These stations have been chosen at the proper distance apart so as to cover the whole of the peninsula and the islands. It is expected that each station will be able to cover a radius of 200 miles. The current is to be furnished by storage batteries. Marconi himself is to have the active supervision of all the stations and will select the best apparatus for the purpose. Nearly all the points chosen have been already used for semaphore signal stations, and thus it will not be necessary to erect special buildings. Preparations are now being made for erecting the main central station at Rome, which will be provided with extra powerful apparatus so as to be able to communicate with a second station in South America.

Some rather curious phenomena have been observed in the case of dielectrics by two German scientists Kiessling and Walter. They use a hard rubber tube containing an internal rod which serves as one electrode of a high-tension discharge. The other electrode is placed near the outside of the tube. When the outer electrode is near the end of the tube the discharge takes place between the two and the spark passes around the end of the tube without piercing it. If the end of the tube is placed in an oil bath so as to stop this discharge, the spark passes through the tube and pierces it. In this case it is observed that the point of rupture is always at the surface of the liquid. They brought out the same phenomenon in a still more striking way in a second experiment. A plate of glass is placed between two electrodes of a high-tension discharge and if a drop of candle grease is placed on the glass the discharge passes through it more easily than before. The hole which is formed by the discharge is always found at the edge of the drop. If the drop is scratched with a fine point or a small hole is made in it, the discharge has a tendency to pierce the glass at this point. In one case the experimenters used a sheet of ebonite 4.2 millimetres thick, with a fifty-centimetre spark. The discharge could not pass through the plate, but when a drop of stearine was placed upon it the plate was pierced through the wax by a spark of only twenty-five centimetres.

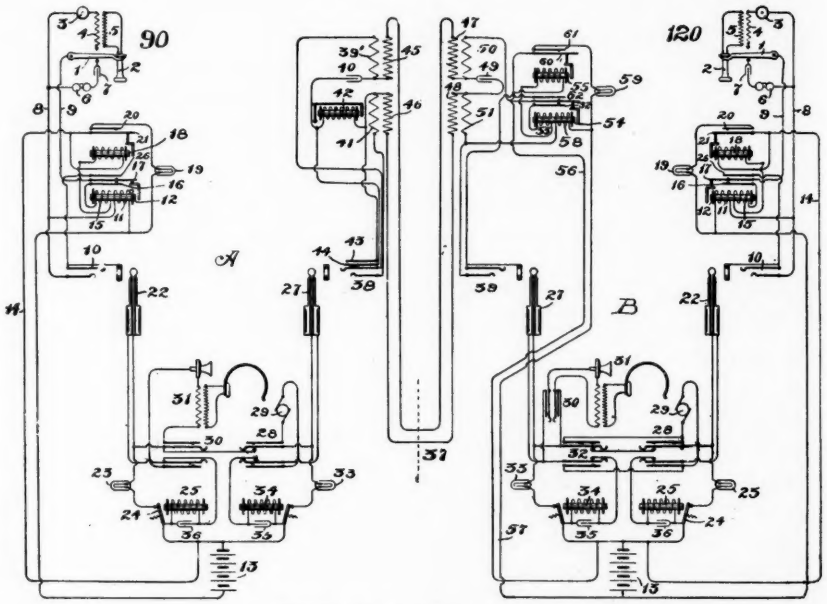
The organizing committee of the Paris Automobile Exposition has already issued the prospectus of the sixth annual Exposition Internationale de l'Automobile du Cycle et des Sports, held in the Grand Palais from the tenth to the twenty-fifth of December. Electrical features will be well represented, as last year, by electromobiles of French and other makes, storage batteries and primary batteries for ignition, also the new method of magneto ignition. The organization, as before, is in the hands of the Automobile Club of France, with the cooperation of the Chambre Syndicale du Cycle et de l'Automobile, the Chambre Syndicale de l'Automobile and the Syndicate of Automobile Constructors. The exhibits are divided into fifteen classes; the first class includes automobiles of all kinds and all vehicles of mechanical make. Only the constructors are admitted to this category. Firms representing foreign makes are admitted only on condition that they exhibit the vehicles of the makes they represent. Class No. 3 provides for exhibitors representing the various makes for which they are the selling agents. Class No. 6 comprises motors for automobiles and boats, also accumulators. Class No. 9 provides for automobile boats, either petrol or electric. Class No. 11, which includes various applications of alcohol for fuel and lighting, will no doubt bring out as interesting a collection of apparatus as last year. Inventions in connection with automobiles, etc., form another class, and a separate class is devoted to publications and photography.

C. L. DURAND.

Paris, September 12.

Electrical Patents.

Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., has obtained control of a patent recently issued to Mr. William M. Davis, of Chicago, Ill., on a telephone exchange system, wherein subscribers whose lines extend to different telephone exchanges may be connected through the agency of trunk lines. The invention has for its specific objects—first, the provision of improved means whereby the operators of different exchanges may signal each other over those conductors employed in effecting a complete connection between subscribers connected with the exchange, thereby dispensing with special conductors that have been generally employed hitherto for the purpose of establishing signal connection between the operators, and second, the provision of means whereby repeating coils may be employed in the trunk line for the purpose of propagating voice currents from one substation to another, in combination with means whereby the common battery employed in the system may not be short-circuited by reason of inductively related closed circuits forming links in the telephonic circuit. While this latter feature of the invention is particularly adaptable for use in connection with repeating coils contained in trunk lines, the invention is not limited to this adaption thereof. The invention can be more readily explained by reference to the accompanying drawing, in which are illustrated two telephone exchanges adapted for union by a trunk line. A subscriber's station No. 90 is connected with the telephone exchange A and a subscriber's station 120 is connected to a telephone exchange B. At each of the telephone substations there is illustrated a gravity switch hook 1, a receiver 2, that may be supported thereby, a transmitter 3, an induction coil having the primary 4, adapted for inclusion in circuit with the telephone line upon the elevation of the switch hook, a secondary 5 included in closed circuit with the telephone receiver, a signal receiver 6, and a condenser 7 included in the signaling branch. When the switch hook occupies its depressed position, the signal receiver is cut into circuit and the telephonic apparatus is rendered inoperative. When the receiver is removed from the switch hook the switch hook is elevated to open the signaling branch containing bell 6 and condenser 7 and to close circuit through the telephonic apparatus. The substations are connected with the exchange by telephone lines, the limbs 8 and 9 of each being connected with the short and long-line springs of the spring-jacks 10 at the exchanges. The limb 8 of each telephone line is continued through the helix 11 of a relay 12 and is connected with one pole of a common battery 13, the remaining pole of this common battery having connection by way of the conductor 14 with one terminal of the second helix 15 of the relay 12. The remaining terminal of the helix 15 is in the form of a contact spring 16, normally engaging a contact carried by the spring 17, which spring constitutes the normal terminal of the limb 9. When the limbs 8 and 9 are conductively united at a substation 90 or 120, circuit from the battery 13 finds passage through both of the helices 11 and



TELEPHONE EXCHANGE SYSTEM.

15, which by being differentially wound do not cause the operation of the relay 12 when thus both included in circuit. There is also included in circuit with the conductor 14 and the helix 15 the winding of a line indicator 18, having a single helix which energizes its core when circuit through the battery 13 is completed upon the elevation of a corresponding telephone switch hook. The signaling magnet 18 preferably presents a signal through the agency of a small incandescent lamp 19, whose circuit is completed as terminals 20 and 21 are engaged upon the energization of magnet 18. The operator in response to the signal conveyed by the lamp 19 inserts a plug 22 into the calling subscriber's jack, thereby including the helix 11 in a momentary closed circuit that contains the tip of the inserted plug, the clearing-out indicating lamp or other signal 23 corresponding to the subscriber whose jack is engaged by the plug 22, the armature 24 of the signal-controlling magnet 25 corresponding to the signal 23, the battery 13, the helix 11, and the short-line spring of the spring-jack 10 engaging the tip of the inserted plug. The spring 17 is thereupon moved from its normal contact to its alternate contact 26, thereby opening the circuit, including the helix 15, and permanently connecting the short-line spring to the battery through the helix 11. It is understood, of course, that the short-circuit momentarily maintained through the lamp 23 causes the coil 11 to exert a greater magnetizing effect upon the core than the differential coil 15, whereby the said relay may be operated. The helix of magnet 18 and the coil 15 of the relay are at the same time cut out of circuit, as the continuity of its circuit depends upon the engagement of the parts 16 and 17. In addition to the plugs 22 there are also provided the plugs 27 united by tip and sleeve strands. There is provided at the board A a ringing key 28 for including the calling generator 29 in bridge of the telephone lines and a listening key 30 for including the operator's telephone appliance 31 in the telephone circuit. Similar keys 28 and 30 are also provided at board B, there being also illustrated at this board a second ringing key 32, so that the generator 29 at this board may be included in circuit with one or the other of the plugs 22 and 27. There is also preferably provided in connection with each cord circuit an added super-

visory signal 33, provided with a controlling electromagnet 34. The magnets 25 and 34 are included in series in the cord circuits, being shunted by condensers 35, 36, included serially in the same cord strands. Having generally described a particular telephone exchange system with which the invention is particularly adapted, the salient features of the improved trunking system will be disclosed. The exchanges A and B may have telephone lines connected therewith united through the agency of said trunk lines, as the trunk line 37 illustrates. This trunk line terminates in the long and short line springs of the spring-jack 38, that are adapted for engagement with the terminal of a plug, and in similar contact springs of a spring-jack 39 at the board or exchange B. The trunk line is made up of three inductively related sections. The first section includes the short and long-line springs of the spring-jack 38, the primary helix 39′, condenser 40, and the primary helix 41. When the trunk-line jack 38 is not engaged with the plug, this first section of the trunk line includes the drop or indicating magnet 42, which is thus normally in condition to be operated from the board B. When the jack 38, however, is engaged by a plug, the helix of its magnet is short-circuited by the engagement of terminals 43, 44 of its helix, by which adjustment it is rendered unresponsive to alternating currents, while its impedance is removed from the trunk-line circuit. The second or middle section of the trunk line is in the form of a local circuit that is closed telephonically. This telephonically closed second or middle section of the trunk line includes secondary coils 45 and 46 in inductive relation with the primaries 39′ and 41 and secondary coils 47 and 48. This middle section also includes the condenser 40, that is common to the first and second sections of the trunk line, and the condenser 49, that is common to the second and third sections of the trunk line, said condensers serving to telephonically close said sections. This third section of the trunk circuit also includes the primary coils 50 and 51 in inductive relation with the secondaries 47 and 48. There is included normally in this third section of the trunk line a circuit-changing spring 52, the helix 53 of a relay 54, the helix of a signal-controlling magnet 55, the conductor 56, the battery 13 at the exchange B, the conductor 57, and the helix 58, that is differentially wound with respect to the helix 53, which arrangement is preserved as long as the jack 39 is not engaged by a plug. This association of the signal-controlling relay 54 and the signal-presenting magnet 55 constitutes one feature of the invention. By this arrangement, assuming that subscriber No. 90 is calling subscriber No. 120, a signal is transmitted to the B operator upon a simple insertion of the A operator's calling-plug in the trunking-jack through the agency of the cord-circuit instrumentalities at the exchange A, which result is secured because the sides of the circuit extending from the calling-operator's exchange to the board B are metallically continuous. If the plug 22 is not inserted in spring-jack 10, the circuit at station A may be closed by the closure of the operator's listening-key, the circuit then including the operator's talking set instead of the apparatus at substation 90. This signal thus automatically transferred through the agency of apparatus at board A is manifested in the signal 59, it being assumed that the relay 54 is not operated, owing to the differential arrangement of its windings. This signal 59 is preferably in the form of a small incandescent lamp and is included in a local circuit that is established by the armature of the magnet 55, which effects the closure of the switch parts 60 and 61, constituting terminals of the circuit, including the lamp 59. The operator at the board B in response to the signal presented by the device 59 inserts a plug 27 into the jack 39, thereby momentarily establishing a local circuit that includes the tip of the inserted plug, the supervisory circuit 33, the armature of the magnet 34, the battery 13, the helix 58, and the short-line spring of the jack 39 in engagement with the said tip. The momentary closure of the circuit causes an increase in the strength of the magnetism due to the winding 58 over that produced by the winding 53, whereupon the armature of the relay 54 is attracted, moving the contact spring 62 from its normal contact anvil, thereby opening the circuit including the helix 53. By the disconnection between the spring 62 and its normal contact anvil the magnet 55 is thrown out of circuit, restoring the signal 59. The spring 62 when elevated engages its alternate contact anvil, thereby effecting a direct-connection between the primary 50 and the long-line spring of the spring-jack 39, thus placing the third section of the trunk line in condition to afford telephonic communication between the calling and called subscribers. The condensers 40 and 49 prevent the short-circuiting of the batteries 13 and 13, which would otherwise take place if the second section of the trunk line were placed in a metallically closed circuit. The condenser 49 by furnishing sufficient impedance to the low-frequency calling current serves to permit the passage of sufficient current from the calling generator 29 at the board B (assuming now that subscriber No. 120 is the calling subscriber and that the operator at the A board is to be signaled) to effect the operation of the drop 42. This signaling current may be traced from one terminal of the generator 29 to the tip of the plug 27, inserted within the jack 39, the short-line spring of this jack, the primary 51, the secondary 48, the secondary 46, the said magnet 42, the condenser 40, the secondary 45, the secondary 47 and the primary 50, the long-line spring of the spring-jack 39, the sleeve of the inserted plug 27 to the remaining terminal of the generator. The condenser 49 taking the place of a metallic continuation of the second section of the trunk line prevents the current from the generator 29 at the exchange B from being short-circuited, forcing the same through magnet 42.

It is well known that electric conductor mouldings as usually constructed are provided with longitudinally extending grooves, together with a cover strip which is fastened to the moulding after

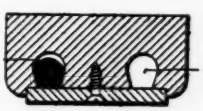


FIG. 1.—MOULDING CLEAT.

the conductors have been seated in the grooves. In practice it is difficult to place the conductors in the grooves and retain them until the application of the cover strip. This is especially true when the mouldings are employed on ceilings, the tendency being for the conductors

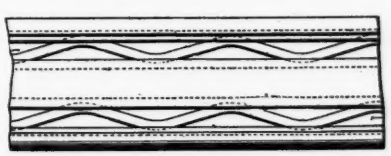


FIG. 2.—MOULDING CLEAT.

to drop out of the grooves before the workman completes the insertion throughout the length of the strip. Mr. Sidney M. Burk, of Philadelphia, Pa., has been granted a patent on a novel construction of moulding, wherein the conductors will be held securely in place. In one form of construction, the grooves in the moulding are dove-tailed, or, in other words, have their inner portions enlarged, as shown in Fig. 1, while the open mouths are contracted so as to be slightly less in width than the diameter of the conductor. Therefore, when such conductor is forced into the groove, it will maintain its position therein. In another form the conductor may be made smaller and twisted or corrugated so that its opposite edges will engage in the enlarged portion of the groove as shown in Fig. 2, and be held by the overhanging walls thereof.

Reviews of Current Engineering and Scientific Literature.

Electrically Driven Mining Plants.

In this article Mr. G. Hooghwinkel discusses the advantages of electrically operated mining machinery, particularly drills, as compared with compressed air-operated machinery. Compressed air machinery is expensive to lay down and expensive to keep up, and as a medium of transport is most cumbersome and inefficient. The disadvantages of the air drill are deafening noise of the exhaust air, no power to draw back the drill from jambs in the boring hole, large amount of power required (about four times that required with the electrical drill), and large amount of space required. As an advantage, it is sometimes stated that the exhaust air may be used in ventilating the face after an explosion, but the air from several drills is about one-tenth of the amount required for clearing away the smoke of the lamps and dynamite and for a sufficient supply of oxygen, and this amount is supplied at an exaggerated cost. Electrical drills are of the rotating as well as the percussion type. They have none of these disadvantages, but have some qualities which recommend them for such work as quick tunneling and where there is not much room. Their use also permits the use of a few electric lamps in the working face. Drills are operated by one or two-horse-power motors and are about thirty per cent cheaper in first cost than an air drill. The first electric drills were operated by solenoids acting upon an iron core, but these heated rapidly and were unsatisfactory. A successful type of drill now used is operated by means of a motor which drives a crank, the latter transmitting motion to the drill by means of buffer springs. The drills require small power, give variable length of stroke, and are not injured by sudden removal of resistance. The motors can also be used to drive a rotating drill. After firing the shots, the motor may be used to drive a small ventilating fan. The author recommends the use of 120 volts, three-phase current, driving induction motors for this work.—*Abstracted from the Electrician (London), August* 28.

Tests of Electric Traction by Simple Alternating Currents.

A single-phase alternating-current motor for traction purposes is being developed by Dr. Georges Finzi, of the house of Brioschi, Finzi & Company, Milan, Italy. Dr. Finzi has been experimenting with the series motor for use on alternating circuits since 1896 and has built and tested several machines, the latest of which has a capacity of about twenty-five kilowatts. This motor has laminated fields and is supplied with current at 180 volts, eighty cycles per second. Much pains has been expended in overcoming sparking at the commutator, and now this difficulty has been met satisfactorily. The air-gap is relatively large, the field winding has been carefully proportioned to the armature, and resistances are used in the connections of the armature windings to the commutator. This motor has been tested in the shop, and last June on a tramway line six kilometres long at Milan. Current is supplied to the line at 570 volts, and was reduced on the car by means of an autotransformer which also allowed voltage regulation to be used. The car weighed nine tons, and there were grades of 2.7 per cent. The speed was forty-five kilometres per hour. The operation of the car under these conditions is compared with that of a similar car on the same line equipped with the standard direct-current motors, and it is stated that these tests show a higher efficiency for the alternating motor, as compared with the direct-current motor, part of which was due to the voltage regulation which was used with the former equipment. Shop tests of the motor gave characteristics very similar to the direct-current motor. The efficiency varied with the load and voltage applied, and under the best conditions was about seventy-eight per cent at a speed of 600 turns per minute and a voltage of 140. The power-factor is low at low speeds, but increases both with the speed and with the voltage until at 1,200 revolutions per minute and 140 volts it was 0.96.—*Translated and abstracted from L'Industrie Electrique (Paris), August* 25.

Friction Between Iron and Wood.

Wooden brakes on iron wheels are in wide use, particularly in hoisting machinery in mines, but there is such a wide variation in the figure used for the coefficient of resistance in designing this machinery that Professor L. Klein, of Hanover, was requested to investigate the subject. His brake pulleys were driven by a small Pelton wheel worked under a constant head. The diameter of the pulley was 15.75 inches, and the brake locks were attached to a lever, from the end of which weights were suspended. The machine having been carefully calibrated, tests were made of various kinds of wood, by varying the speed, varying the pressure and varying the surface of the brake. As a rule, the wood fibre was parallel to the pulley face, though tests were made both with the grain across the pulley face and with it end on. The brake wheels were of wrought iron and cast iron, both smooth and rough. The braking effect is much smaller with the rough pulley and the values fluctuated more than with the smooth pulley. Rough pulleys wear the wood badly. Beech and oak suffered more than poplar, elm and willow on rough pulleys. The former woods proved more efficient, probably because the charred particles smoothed out the rough spots. Elm, poplar and willow were not charred. Poplar was found to be the best brake block material. It gives high friction and is little sensitive to oil. Carefully finished and cleaned wrought iron is a better pulley material than rough wrought iron or cast iron. It was found that, within limits, the speed and pressure did not affect the friction coefficient. Many hundreds of tests were made, a few of the results of which are given in tables from which the following values are taken: The coefficients of friction on a smooth wiped wrought-iron pulley, with the fibre parallel to the face, were, for beech, 0.53; for oak, 0.51; for poplar, 0.65; for elm, 0.60, and for willow, 0.63. —*Abstracted from Engineering (London), August* 21.

Electrical Resistance of Hydraulic Cement.

Although mortars and cements have a considerable resistance when dry, this property is greatly affected by humidity, so that it is impossible to consider these materials, under ordinary conditions, as insulators. M. R. Feret has carried out some interesting experiments upon the change of resistance of various cement mortars, particularly investigating the change of the resistance with time. The first work was carried out on blocks of cement four centimetres square and sixteen centimetres long. These had been allowed to set for a day after mixing, and had then been kept in water for a number of years. The samples consisted

of both Portland and Roman cement mixed with various proportions of sand. The blocks were clamped in a frame between plates of copper, and the resistance was determined by means of a high-resistance voltmeter. During the test the samples of cement were placed in an oven and gradually dried. The sample consisting of pure Portland cement after one hour showed a resistance of over 1,000,000 ohms. The other samples showed a lower resistance, but this gradually rose to the figure given, the time required increasing with the increase in the proportion of sand. The samples of Roman cement showed in general a higher resistance and a more gradual change with time. Experiments were then made to determine the change of resistance of samples during setting. For this purpose the various mixtures of cement and sand were placed in small boxes lined with oiled paper and in contact with terminal plates of copper. During the setting process the resistance rose gradually without showing any sudden changes. This work was repeated by pouring the mixtures into glass tubes placed in a vertical position in order to avoid any errors which might be introduced by a layer of water collecting upon the surface of the samples when placed horizontally. In this case the resistance of the various samples changed slightly for a time and then suddenly increased, the curves showing a decided knee. It is suggested that these knees may indicate definite steps in the hardening of cements, and the process of setting may be somewhat analogous to the cooling of steel.—*Translated and abstracted from l'Electricien (Paris), September 5.*

Compensation of Asynchronous Motors.

Mr. H. S. Meyer has here brought together some notes on the advantages and disadvantages of the compensated asynchronous motor, as compared with the simple induction motor. The advantages claimed for the compensated induction motor are unity power-factor at all loads, greater overload capacity and higher all-around efficiency. It is practically impossible to obtain unity power-factor at all loads, because this would necessitate continually shifting the brushes and changing the exciting voltage by hand. While the power-factor curve of the compensated motor is flat, it is not a straight line, and a power-factor of 0.99 means a fourteen per cent wattless current. Although the power-factor is increased by compensation, it is not thought that the advantage gained outweighs all the disadvantages introduced thereby. As regards the greater overload capacity of compensated motors, it must be admitted that the rotor flux, on which the overload capacity is chiefly dependent, will be larger in the compensated motor. However, at overloads leakage will be present and the difference will not be so marked. The advantage of greater overload capacity due to the larger rotor flux would in most practical cases be only apparent, since the output of the motor is almost entirely limited by the efficiency and the heating, and in these points the compensated motor can hardly give increased figures compared with the standard type. It is claimed that compensation allows certain modifications which cheapen the design, such as increasing the air-gap, fewer slots on the motor, and a smaller diameter and greater length of the motor; but the author thinks that these are of only secondary importance. The increase in efficiency due to compensation will be reduced by the commutator losses, both electrical and mechanical. The commutator is thought to be a decided disadvantage, as it will be very difficult in practice to avoid sparking, particularly when starting or in regulating for speed. Reference is made to Heyland's latest recommendation of a device for lifting the brushes off the commutator during starting, and replacing them when running, at the same time lifting the brushes from the slip rings. This suggestion seems to indicate that there is difficulty in starting the compensated motor. In Mr. Meyer's opinion there are hardly any practical cases where the compensated induction motor would be preferable to the ordinary induction motor; and as long as the commutator is not used for improving either the starting conditions or for obtaining a more efficient speed regulation, it will find no field in alternating-current motors.—*Abstracted from the Electrician (London), September 4.*

The Largest Storage Battery in Canada.

In a description of the power plant of the Ottawa (Can.) electric railway, Mr. John Murphy gives some particulars of what is said to be the largest storage battery in Canada. This consists of 288 cells of the Electric Storage Battery Company's latest improved chloride accumulators. The elements of the battery are contained in lead-lined wooden tanks which have been made large enough to permit of a fifty per cent increase in the number of plates and in the output of the battery. Each tank now contains twenty-five type G plates, but there is space in each for thirty-nine plates. The tanks rest upon porcelain insulators supported by well-seasoned pine stringers, water-proofed, and which, in turn, are separated from the concrete floor by vitrified bricks. The maximum discharge and charge rates of the battery are 1,000 amperes and 300 amperes, respectively, enabling the battery to take care of load variations amounting to 1,350 amperes. Before the battery was installed, when the necessity for increasing the plant arose, three propositions were considered: An increase of the present water power installation, the addition of a steam-driven generator, or the battery installation. The latter course was decided upon because it would improve immediately the service by maintaining a constant voltage at the power-house, irrespective of load changes, and for the further reason that it would prolong the life of the hydraulic plant, not only by relieving the water-wheels and gates from jars caused by sudden variations in load, but because it would also act as an addition to the plant, as it can be charged during hours of light load and discharged during the peak hours. Up to the time the battery was installed the water-wheels and the generator voltage had been controlled by hand, but not with entire satisfaction. When the battery was installed the voltage was increased from 550 to 600, and it now remains constant, irrespective of the conditions of the load. The batteries are charged by a differentially wound motor-driven booster which maintains a constant load on the generator. The water-wheel gates are not moved at all for speed regulation, but are set so as to make the generator carry the average load.—*Abstracted from the Canadian Electrical News (Toronto), September.*

Speaking Flames.

Some time ago Simon, Duddell and others exhibited electric arcs which could speak or act as telephone receivers when they were properly connected to a microphone. Now two Russians show how to make an ordinary flame speak. Wires from poles of the secondary circuit of an induction coil are led to insulated Bunsen burners, paraffin lamps, or short candle ends. A microphone and battery are placed in a shunt to the primary circuit of the coil. On speaking to the microphone the flame repeats the sound, although it is thirty yards from the microphone. The effect is better when two flames are employed, a pole of the secondary coil being connected to each and a third wire connecting the two flames.

NOTE ON SOME THEORETICAL CONSIDERATIONS IN THE CONSTRUCTION OF RESISTANCE FURNACES.[1]

BY FRANCIS A. J. FITZGERALD.

Electric furnaces are usually divided into two great classes—arc furnaces and resistance furnaces. The latter class may be divided into two sub-classes—furnaces in which the current passes through the whole charge and those in which the current passes along a definite path or paths, thus localizing the heat. It is to the latter type that this paper will chiefly apply, although some reference may be made to the former. An apology for this paper seems necessary, since to those who have done much work of this kind the considerations presented will appear to be obvious and elementary. But it is believed that those who have had little experience in the construction of furnaces may find here some suggestions that will be of assistance in furnace design.

Of the various electric furnaces that have been developed, those due to Mr. E. G. Acheson present unusual interest, because they cover a considerable range of temperature and involve certain conditions as to accurate temperature regulation.

Graphite Furnace—In this furnace the highest temperature attainable is desired. The carbonaceous material, anthracite coal, coke, etc., is placed in a trough-like furnace, and through the centre of the charge is a series of carbon rods connecting the furnace terminals. Anthracite coal, the raw material usually employed, is practically a non-conductor of electricity, and at first the current passes through the core of carbon rods. The heat generated in the core converts the surrounding coal into graphite, which then becomes a conductor and heats another layer of coal, and so on till the process is complete. This furnace belongs to both sub-classes of the resistance type.

Electrode Furnace—The furnace belongs to the first sub-class, but is peculiar in that the heat is mainly generated outside the article under treatment. In the most general case the electrodes to be converted into graphite are arranged in piles, and the spaces between the latter filled with granular carbon. Since the resistivity of the granular carbon mass is much greater than that of the electrodes, most of the heat energy will be developed in the former. The advantage of this type of furnace is that it permits of treating a large mass of low-resistance material without using currents of excessive amperage.

Carborundum Furnace—Carborundum is a substance that is decomposed at the temperature of the graphite furnace, hence in its manufacture careful temperature regulation is necessary. The charge, consisting of sand and coke, in the form of powder, is put in the box-like furnace, and through its centre passes a conducting core, which may consist of carbon in a granular form, or of carbon rods, connecting the terminals of the furnace. The current is confined to the core, raising it to a high temperature, and the heat generated is conducted into the surrounding mixture, converting it into carborundum. If the temperature of the furnace is too high, the carborundum is decomposed and the silicon vaporized.

Furnaces for Moderately High Temperatures—This is the latest of Acheson's patents, and is of great interest. In the outer zone of the carborundum furnace, just outside the crystalline silicon carbide, is a thin layer of an amorphous substance, known as "white stuff." It is an intermediate product in the formation of carborundum, and the temperatures between which it is formed and decomposed apparently lie near one another. For this reason its manufacture, or that of like compounds, involves serious difficulties, and it was to overcome these that Acheson invented this furnace. The furnace is of the same general form as that used in the manufacture of carborundum, but it contains several cores, which are "definitely spaced with relation to each other at distances largely determined by the heat conductivity of the charge, the duration of the operation and the superior and inferior temperature limits of the operation."[1]

In all of the furnaces described above there is one common characteristic—the electrical resistance is a variable quantity, and after any furnace is started there are no means of adjusting internal conditions so as to effect regulation in this respect. In general, the resistance of these furnaces is high at the beginning of a run and low at the end; therefore, means of varying the voltage at the furnace terminals must be used. If the furnace resistance at the beginning of a run is R, at the end of the run r, the maximum voltage attainable E, the minimum voltage e and the maximum watts W, then the following equations must hold:

$$R = \frac{E^2}{W} \qquad (1)$$

$$r < \frac{e^2}{W} \qquad (2)$$

The application of these equations to the various furnaces considered is obvious. The resistance of the furnace may be varied by altering the dimensions of the core or that part of the furnace which acts as an electrical conductor. Later we shall see that there are limits to the variations that can be made in this respect on account of other considerations; but the resistivity of a mass of carbon granules varies with the size of the latter, and further variation may be obtained by the judicious choice of different forms of carbon, which themselves have different resistivities. By taking advantage of this, any desirable variations in the resistance of the furnace may be obtained. The case of the electrode furnace is a special one, the adjusting of the resistance being obtained, to a certain extent, by the spacing between the piles of electrodes.

If a cylinder is kept at a constant temperature, θ_1, and is surrounded by a heat-conducting material, then the quantity of heat, Q, passing from the cylinder into the surrounding material per second is given by the equation

$$Q = 2\pi\rho_1 LK(\theta_1 - \theta_2)$$

where ρ_1 is the radius of the cylinder, L its length, θ_2 the temperature of the surface of the material in contact with the cylinder and K is a constant. Then

$$\theta_1 - \theta_2 = \frac{Q}{2\pi\rho_1 LK}$$

Now, if θ_2 is a constant and a certain quantity of heat, Q, is developed in the cylinder, then, in order that θ_1 may be kept constant, ρ_1 L must have a definite value. If the cylinder is a conductor heated by a current of W watts, then

$$\frac{W}{\rho_1 L} = \text{constant} \qquad (3)$$

If the material surrounding the cylinder is in the form of a second cylinder, coaxial with the first, then if ρ_2 is the radius of the second cylinder, K^1 the heat conductivity of the material of which it is composed and θ_3 the temperature of its outer surface, it may be shown[1] that

$$Q = \frac{2\pi LK^1(\theta_2 - \theta_3)}{\log\frac{\rho_2}{\rho_1}} \qquad (4)$$

Next let it be assumed that the outer cylinder is surrounded by a material hav-

[1] A paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 17, 1903.

[1] United States patent 738,631, March 24, 1903.

[1] In this case the isothermal surfaces about the cylinder are a series of coaxial cylinders, and the lines of flow of the heat form tubes of flow having the shape of wedges, with their edges lying parallel to the axis of the cylinder. Planes parallel to the axis of the cylinder will cut off from the wedges rectangles of equal length, having widths proportional to their distances from the axis; therefore, the heat passing through unit area of the rectangles will be inversely proportional to their dis-

ing a heat conductivity k, and that a certain amount of heat is absorbed at the outer surface of the cylinder, then applying equation (4) to an isothermal surface, outside the cylinder, having a temperature θ_4 and a radius ρ_3, the quantity of heat passing from the cylinder to the isothermal surface per second is

$$q = \frac{2\pi L k (\theta_3 - \theta_4)}{\log \frac{\rho_3}{\rho_2}}$$

or if $\rho_3 - \rho_2 = t$, and t is very small,

$$q = 2\pi L k (\theta_3 - \theta_4) \frac{\rho_2}{t} \qquad (5)$$

In using the results obtained from these calculations, it must be remembered that they only apply approximately, representing as they do hypothetical conditions and involving various assumptions that are not rigorously correct. Keeping this in mind, the various furnaces described may be considered.

Graphite Furnace—The furnace having been designed so as to fulfil the conditions of equations (1) and (2), it remains only to apply equation (5). The heat developed in the furnace is used in various ways—in raising the temperature of the furnace charge; in effecting chemical changes; in vaporizing substances other than carbon; in supplying heat lost by radiation. With the exception of the last, all these items represent useful work. The last item is represented in equation (5), and, leaving all other losses out of consideration, the efficiency of the furnace is given by the equation

$$\text{Efficiency} = \frac{Q - q}{Q} \qquad (6)$$

In order, therefore, to make q as small as possible, K and $\theta_3 - \theta_4$ should be small. The important point to observe, however, is that a furnace may be made indefinitely large so far as equations (1) and (2) are concerned, but equation (5) sets a limit, since q varies directly as the product of L and ρ_2.

Electrode Furnace—The equations apply to this furnace in a similar way to the previous one.

Carborundum Furnace—Applying equation (4): ρ_1 is the radius of the core, or the inside of the carborundum cylinder, θ_2 the temperature of that surface, ρ_2 the radius and θ_3 the temperature of the outside surface of the carborundum cylinder, while K^1 is the conductivity of the crystalline mass. The equation may be written

$$\log \frac{\rho_2}{\rho_1} = \frac{2\pi LK^1 (\theta_2 - \theta_3)}{Q}$$

In order, therefore, to make the maximum amount of carborundum around the core, K^1 must be as great as possible. This can be best accomplished by having the mixture surrounding the core of high density, for then the crystal mass formed will also be dense. $\theta_2 - \theta_3$ should also be as large as possible, but θ_3 is a constant, the temperature just below that of the formation of carborundum; therefore, θ_2 should be as large as possible. But θ_2 can not be indefinitely increased, for above a certain temperature carborundum is decomposed. Hence equation (3) applies here, for the value of ρ_1 L must be such that the core temperature shall be just less than that which will ensure the decomposition of carborundum.

Finally, in considering the outside of the carborundum cylinder, equation (5) is used. As before, k and $\theta_3 - \theta_4$ must be kept as small as possible. Nothing can be done to diminish k, as the material outside the carborundum must of necessity consist of the mixture of sand and coke. Fortunately, the mixture has a very low heat conductivity. $\theta_3 - \theta_4$, however, may be kept small by leaving a good thickness of unchanged mixture outside the carborundum. It will be observed that since the value of ρ_2 increases with the length of the run, a point will finally be reached where q is equal to Q in equation (6); or, in other words, the efficiency of the furnace continually diminishes as the length of the run increases, and a point is at length reached where no more carborundum is made. In order to work efficiently, the run must be stopped long before that point is reached.

Furnaces for Moderately High Temperatures—Here the conditions are similar to those in the carborundum furnace, but more complicated, as there is a multiplicity of cores. However, the theoretical considerations that have been discussed will still prove useful in giving a general idea of the furnace design.

In no case that has been considered can the various fundamental equations be rigorously applied, for, as has been pointed out already, these involve numerous assumptions that do not represent the actual conditions, and take no account of certain conditions that are invariably present. Nevertheless, it will be found that keeping the theoretical considerations in view is a great help in the building of furnaces, and prevents waste of time in experimenting with designs that can not possibly be satisfactory.

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tances from the axis. The equation from the flow of heat is

$$\frac{d\theta}{d\rho} = \frac{a}{\rho}$$

where a is a constant; hence

$$\theta = -a \log \rho + b$$

then at the inner and outer surfaces of the second cylinder

$$\theta_2 = -a \log \rho_1 + b$$
$$\theta_3 = -a \log \rho_2 + b$$

so that

$$a = \frac{\theta_2 - \theta_3}{\log \frac{\rho_2}{\rho_1}}$$

The quantity of heat passing through the cylinder per second is

$$Q = -2\pi\rho LK^1 \frac{d\theta}{d\rho}$$
$$= 2\pi LK^1 a$$
$$= \frac{2\pi LK^1 (\theta_2 - \theta_3)}{\log \frac{\rho_2}{\rho_1}}$$

American Institute of Electrical Engineers.

The September announcement of the American Institute of Electrical Engineers contains an attractive programme for the first meeting of the fall session, Friday, September 25. The following papers are announced.

"An Efficient High-Pressure Water Power Transmission Plant," by George J. Henry, Jr., associate, engineer Pelton Water Wheel Company, and Joseph N. Le Conte, associate, instructor of mechanical engineering University of California.

"Electric Motors for Centrifugal Pumps and Fans," by August J. Bowie, Jr., associate, engineer electric department Union Iron Works, San Francisco, Cal.

"A Suggested Hydraulic Unit," by Ralph L. Montagu, associate, consulting engineer, Oroville, Cal.

The new meeting place of the Institute is the New York Academy of Medicine, 17 West Forty-third street.

Railroad Employes' Carnival.

The employés of the Brooklyn Rapid Transit Company held their annual seaside outing at Luna Park, Coney Island, this year, on September 14, 15, 16, 17 and 18. The returns from the sale of tickets for this outing go into the treasury of the employés' association which gives relief to the members or families of members who may be in distress. The management of Luna Park, Messrs. Thompson & Dundy, inaugurated a series of additional attractions on Labor Day, September 7, and these were thoroughly enjoyed by the participants in the railroad employés outing.

Luna Park has become renowned for the extent and variety of its attractions. The use of electricity is one of the most significant features of this collection of entertainments. The park covers twenty-two acres and cost $1,500,000. There are 224,000 incandescent electric lamps used, and the current for these is supplied by the Brooklyn Edison Company from the regular service mains. The park is scheduled to close on October 1. At present and up to the closing of the park a series of Indian summer carnivals will be undertaken.

Fourth General Meeting of the American Electrochemical Society.

THE fourth general meeting of the American Electrochemical Society was held at Niagara Falls, N. Y., September 17, 18 and 19. The meeting was well attended, there being 136 members and guests registered. The weather for the first day was exceedingly disagreeable, making traveling uncomfortable, but the remainder of the week was bright and cool.

The meeting of the board of directors was held at nine o'clock on Thursday, September 17, and the general meeting of the society was called to order by President Richards in the auditorium of the Cataract House at 10.30 A. M. In opening the meeting, President Richards spoke of the successful year the society had had, stating that there were now 600 members, thirty-five having been elected during the month. The report of the treasurer showed that the treasury was in a flourishing condition, having a surplus of $2,000. President Richards also stated that the executive committee had arranged with the Faraday Society, of England, for an exchange of transactions. The members of the American Electrochemical Society will receive free of cost the monthly issues of the *Electrochemist and Metallurgist,* and in return the members of the Faraday Society will receive the yearly transactions of the American Electrochemical Society free. Although this will entail considerable expense upon the society, there will be no increase in dues. It was further announced that the board of directors had taken action authorizing the establishment of local sections, at which monthly meetings may be held. Regulations governing the organization of these sections will be drawn up. The first application for a local section was made on behalf of the University of Wisconsin by Professor C. F. Burgess, the second application being made by the New York members for a section in New York city.

Mr. F. A. J. Fitzgerald, of Niagara Falls, N. Y., was then called upon for his paper on "Some Theoretical Considerations of Resistance Furnaces." This paper will be found in full on other pages of this issue. Mr. Fitzgerald described the several types of electric furnace and presented formulæ for calculating the design of any of these when the constants of the material used are known.

The discussion was opened by Professor C. F. Burgess, of the University of Wisconsin, Madison, Wis., who asked what the power-factor of these large furnaces is.

In reply, Mr. Fitzgerald said that, in general, the power-factor is not unity, due to the very heavy currents used and the inductance of the leading-in cables and bus-bars.

Mr. Alfred H. Cowles, of Cleveland, Ohio, asked whether in the use of these furnaces a suboxide of silicon had ever been identified. He said that in 1885 he was working with an experimental furnace and made carborundum. He noticed that a yellow substance was formed beyond the carborundum crystals, and thinking it might be a suboxide of silicon, he submitted some to an analyst, who advised him that this was the case.

Mr. Fitzgerald said that he had many analyses of the "white stuff" formed in the carborundum furnace, but had never found the suboxide of silicon.

In reply to a question regarding the units and constants of his equations, Mr. Fitzgerald replied that the equations he had worked out were not applied except roughly; that they were intended merely as guides in the construction of furnaces, and did not have much value except in a relative way. In working out these equations too many points had necessarily been omitted.

Mr. Cowles asked whether in the carborundum furnace the carborundum itself conducted. He had made an experiment to determine this, constructing a furnace in which the bottom could be dropped out, carrying with it the graphite core. The furnace was put into action, and after the current had been passing for some time the bottom was drawn out with the graphite core, but the current taken by the furnace fell only one-third. This seemed to him to show that the carborundum conducted. He had also fused carborundum by passing a current through it.

Mr. Fitzgerald thought that carborundum was practically a non-conductor. In constructing this furnace the core is built up of granular carbon which changes throughout the process, the resistance varying with it. However, carborundum will conduct when hot.

Professor C. F. Burgess stated that he had made some conductivity measurements of carborundum, and had found it to be a poor conductor compared with carbon.

Mr. Marcus Ruthenburg, of Philadelphia, Pa., then read his paper entitled "Advances in Electrometallurgy of Iron Production." At the last meeting of the society he had presented a paper upon the electrometallurgy of iron, and the figures which he then gave for the power consumption had been criticised both in the discussion and by the technical press. The paper now presented was to give further figures showing what had been accomplished. While the blast furnace was a highly economical device for accomplishing its end, some classes of ore may now be more cheaply reduced to metal by other means, making a product whose analysis can not be produced in a blast furnace at all. Given a magnetic ore carrying gangue, silver and phosphorus in prohibitive quantity for making good steel economically, such ores find no market tributary to the blast furnace.

In last year's paper he made the assertion that "the work of the electric furnace was performed upon a ton of ore with something less than 500 kilowatt-hours of energy."

Upon this basis one of the members accorded him an efficiency of eighty-three per cent, which he followed up by saying it was impossible. In truth at that time he was doing ten per cent better than that, or an efficiency, according to his figures, of 91.3 per cent. To-day he is doing the same, but better work, with one-half the kilowatt-hours reported last year. Three problems have presented themselves for solution, in the conduct of his work; first, the power required to agglomerate and heat sufficiently for subsequent reduction; second, the regulation of the size of the agglomerated particles; and third, the amount of reduction of the agglomerated material.

The status of those three problems today is that a ton of ore is being agglomerated with an expenditure of about 250 kilowatt-hours.

The size of the product is under perfect control.

The reduction is being made absolute. Inasmuch as the only function of the electric current is to agglomerate the dusty particles into coherent masses without binder or flux, and to convey a sufficient quantity of heat to the ore in the soaking pit, to permit the reducing agents to perform their functions, it will be readily comprehended that the heat and current losses due to maintaining a molten mass are lacking.

In reply to the question of Mr. C. J. Reed, as to the basis for calculations of

efficiency, Mr. Ruthenburg stated that he makes no calculations of efficiency. He knows the power taken and the cost, he uses electrical measuring instruments, and his recording wattmeter gives him at any time the energy taken by the furnace. The iron ore, after it leaves the rolls, where it is fused, is reduced by hot carbon monoxide at a comparatively low temperature. He stated further that he uses only magnetic ore containing a small amount of sulphur, which is practically all eliminated. The phosphorus is removed in a magnetic concentrator. He gets with this process a ninety-two per cent reduction. The reduction is made in a magnetic field, the magnets being covered with carbon to prevent the ore welding to them. The ore, after being fused, falls into the soaking pit with not more than five per cent of the oxide present, which is eliminated by the carbon monoxide. The sulphur is eliminated by mixing a proper proportion of the sulphides with the oxides. The sulphur reacts with the oxygen, forming sulphur dioxide, atmospheric oxygen not being used. The reaction takes place purely between the two salts of iron.

Mr. Cowles said that the same reaction takes place with lead, sulphur being eliminated in this way. He had examined Mr. Ruthenburg's furnace and he thought that the temperature of the material in the soaking pit was a little higher than that of molten copper. As copper melts at about 1,100 degrees centigrade, Mr. Cowles put the temperature of the material in the soaking pit at 1,200 degrees centigrade.

Replying to a question of Mr. F. M. Beckett, of Niagara Falls, Mr. Ruthenburg said that the sulphur is not eliminated by his process when carbon is present. It is very essential to maintain a correct temperature if the reaction is to be successful. Mr. Beckett said that he had done much experimental work on an electric furnace for producing iron, but it had not been able to eliminate the sulphur. He worked up to 2,000 degrees centigrade, and had come to the conclusion that the reaction mentioned above does not take place.

Mr. Ruthenburg stated that he was producing metallic iron by his process, free of sulphur—that is to say, that the sulphur did not show upon test.

President Richards explained that Mr. Ruthenburg was working with magnetic ore which contains little sulphur. He said that his calculation of the efficiency of the Ruthenburg furnace had been based upon an assumption of a higher temperature. If the temperature given by Mr. Cowles is correct, the efficiency, as calculated, would have to be reduced in proportion. The process may be successful as now proposed, but it can hardly be used as a preparation for the blast furnace.

Mr. Ruthenburg stated that he still contemplated the application of his process as a preliminary treatment for certain ores which will warrant the expense. The cost at present is about sixty-two and one-half cents per ton, and this can be borne in sections where coal is cheap.

President Richards stated that the electric furnace would have a large place in the metallurgy of iron and steel in the future. When processes have been developed, this will probably be the largest branch of metallurgy.

Professor C. F. Burgess then presented a paper entitled "The Practical Utilization of the Passive State of Iron," an abstract of which will be found on another page of this issue. The first session then adjourned.

During the afternoon visits were made to the power-houses and certain electrochemical plants. The Niagara research laboratories were thrown open to the society. The present building is being fitted up with appliances for all kinds of electrochemical and electrometallurgical work. Companies or individuals who desire to carry out research along electrochemical lines will be able to rent space and power, and use the machinery which is being installed.

The works of the Electric Lead Reduction Company were also visited, and the new type of cell, which was later described by the inventor, Dr. P. J. Salom, was shown in operation.

In the evening a very enjoyable smoker was held under the auspices of the local committee at the Cataract House, at which an excellent musical programme was rendered.

FRIDAY, SEPTEMBER 18.

Friday morning the second session was called to order by President Richards at 10 o'clock.

Mr. Ivar Juel Moltke-Hansen, of Perth Amboy, N. J., presented a paper entitled "An Experiment in the Electrolytic Determination of the Basicity of Acids." Electrolytic methods of determining the basicity of acids are of the highest value in many cases where complex acids of doubtful basicity are in question. The author has applied the electrolytic method to the different metaphosphoric acids. The method used in making the conductivity measurements is due to Kohlrausch, in which a Wheatstone bridge is made use of, but an alternating current and a telephone replace the usual battery and galvanometer. In carrying out the work it was found that the conductivity of the water influenced the results considerably, so that it was necessary to make up a solution from one sample of water and use this throughout the entire work. Solutions of various percentages were prepared and their conductivities measured. These determinations of the conductivity of the solutions show the acid to be dimetaphosphotic acid, according to Ostwald's law, and that it has the following formula:

$$(NH_4PO_3)_2\ 2H_2O$$

Work has also been started to determine the rapidity of the migration of the ions for this salt, but these determinations have not yet been completed.

A paper was presented by Dr. W. H. Walker, of Boston, Mass., entitled "The Electrometallurgy of Gold." Dr. Walker first sketched briefly the various electrolytic methods which have been developed for the extraction of gold from its ores. While these processes are in use in various places, none of them has been eminently successful, principally because it is necessary to handle large quantities of ore. In all of these the gold is first dissolved in a solution—usually potassium cyanide—and is then deposited on another metal. While carrying out some experimental work on these methods, an apparatus was set up in which the ore was laid on a plate of aluminum, and the cathode plate suspended above it in solution. It happened that the connections became reversed, so that the lower plate carrying the ore became the cathode. When this was discovered and the plate examined, it was found that gold in the metallic form had been precipitated upon the aluminum plate, presumably by cathodic reduction. Further work along this line showed that it was possible to precipitate the gold in this way on various metals, and plates were shown on which the metallic gold could be seen clearly. The action was thought to be a reduction of the telluride of gold by means of the hydrogen set free at the cathode. The author stated that, although successful as a laboratory experiment, this method could not be applied commercially because in it it is essential that every particle of gold ore be brought into intimate contact with the cathode plate.

A paper was presented by Dr. Wilder D. Bancroft, of Cornell University, Ithaca, N. Y., entitled "Electrolytic Copper Refining," this being illustrated

by lantern slides. An abstract of Dr. Bancroft's paper will be found on another page of this issue. Dr. Bancroft describes a long series of experiments undertaken to determine the best conditions of electrolyte and current density for use in copper refining processes. The result of this work indicates that in order to operate a plant most economically copper should be refined electrolytically in covered tanks with a current of three and one-half amperes per square decimetre at a temperature of seventy degrees Fahrenheit.

A communication to the discussion of this paper from Mr. Lawrence Addicks, of Perth Amboy, N. J., was read by President Richards. According to Mr. Addicks, Dr. Bancroft has not considered all the effects which enter into copper refining. While good adherent copper can be obtained at almost any density, if the rate of circulation is sufficient, in the latter point we are limited to a slow rate of circulation; otherwise a turbid solution results. Insufficient circulation means poor deposition and necessitates frequent renewal of cathode sheets to maintain the current efficient, and entails a corresponding increase in labor cost. The Anaconda plant, with a density of ten and one-half amperes per square foot, draws copper every thirty-five days; the Great Falls plant, with forty amperes per square foot, every two days. He thought that Dr. Bancroft should have considered the labor cost. He had compared the figures given by him for the influence of differences of concentration in producing counter-electromotive force, and found that these agreed very satisfactorily with the figures obtained on a large scale. The work on temperature coefficients is very complete. He thought that recommendations regarding covering the tanks would not meet with much favor, as it is difficult, even with open tanks, to obtain thorough inspection. The application of covering would be simpler in the case of series tanks than for multiple. In making calculations of cost the question of interest on the metals tied up arises. Many refineries are not charged with this interest at all, the owner of the copper allowing so many days gratis for the refining; but every refiner is charged with interest and depreciation on his plant, and figures for this were not taken into account. These changes, he thought, would revolutionize the cost tables. While Dr. Bancroft has furnished some valuable data, and for some refineries his conclusions are true, Mr. Addicks protested against their application to every plant that can obtain power for $20 a horse-power-year, and raised the question of how many refineries are obtaining power for that figure.

A communication was received from Mr. Benjamin Magnus, of Anaconda, Mont., and was read by President Richards. Mr. Magnus's experience has been that the ampere efficiency depends entirely upon mechanical conditions. If the tank is kept free of most local short-circuits, it is easy to attain a desirable maximum ampere efficiency. A good efficiency in practice is ninety-five per cent, and while he has succeeded in raising it to ninety-seven and one-half, the extra labor was not saved by the extra saving in power. Dr. Bancroft states that the solution deteriorates more rapidly at the higher temperature and at the lower current densities. This Mr. Addicks has found to be true for high temperatures, but not for low current densities. At Anaconda, where the current density is low, they have been using the same electrolyte continuously for many years. At other plants where the current density is sixty per cent higher, it is found necessary to renew part of the electrolyte quite frequently. He questioned whether the green color of the solution was due to the presence of ferrous arsenate, as stated by Dr. Bancroft, and was more inclined to attribute it to an impoverishing of the solution. High current densities cut down the interest on copper tied up and the cost on investment for plant. Although Dr. Bancroft states that the number of men employed does not vary with the current density, as a matter of fact, plants having high current densities usually have higher labor costs per ton of copper. In regard to using covered tanks, a casual inspection would soon convince a visitor of the objection to this practice. The communication concludes with a statment of the conditions at the Anaconda refinery. The current density is 10.5 amperes per square foot, the temperature of the electrolyte is 100 degrees Fahrenheit and the circulation of the electrolyte is three gallons per minute. Under these conditions the chemical action in the tank is one per cent greater than the electrolytic action, and the voltage per tank is 0.23 volt. In order to keep the solution constant day by day, the extra copper taken up by the solution, due to the one per cent greater chemical action, is taken out by means of a tank which has insoluble anodes. The cost of operating this tank is at least eight times the cost of operating a regular depositing tank. (The voltage being two.) Most electrolytic plants use exhaust steam for heating the electrolyte, but even if they used live steam, which cost $80 per horse-power-year, the cost of heating the electrolyte per ton of copper produced would only be from sixteen to thirty-five cents; and if they raised the temperature of their solution to seventy degrees centigrade and raised the current density to 31.5 amperes, the excess chemical action would be so great that to free the electrolyte from copper, by means of tanks having insoluble anodes, would cost so much that the saving of power due to warmer solutions would be more than offset.

Mr. W. McA. Johnson described some work which he had carried out on nickel, similar to that of Dr. Bancroft. He thought that the change in resistance mentioned in the paper was due to the deposit of slime on the anode cells, as well as to the change in concentration. To prevent an uneven deposit on the cathode he had found that a vertical plate of slate, placed against the bottom of the cathode, was very effective. The return of scrap copper is not a linear function of the current density, but increases rapidly. This might more than make up for the saving due to high current density. The regeneration of the electrolyte also increases at a greater rate than the current density. He suggested that the research be extended to an examination into the behavior of the impurities contained in the anodes.

Replying to the discussion, Dr. Bancroft said that he did not agree with Mr. Addicks that it was impossible to get pure copper at a high current density. "The Anaconda copper is supposed to be good." Mr. Addicks says interest is not to be charged, while Mr. Magnus thinks it is. An analysis of the solution showed the presence of both arsenic and iron, though he would not claim that the two were in combination. He did not think that regeneration at seventy degrees would cost more than at fifty degrees, the temperature now in general use; nor does the depreciation of the plant figure largely. He had found that the increase of resistance due to the slimes on the anode was smaller than he had anticipated. It was found that the conductivity of the solution could be brought back to the normal by adding acid. As regards the feasibility of using covers on the tank, it is merely a question of whether the saving was worth while. At sixty degrees a saving of thirty-seven per cent could be effected, while at fifty degrees a saving of fifty per cent could be effected by adding covers, no other change being required.

A paper by Oliver W. Brown, of the University of Wisconsin, Madison, Wis., entitled "The Efficiency of the Nickle-Plating Tank," was read by Mr. Johnson. An ideal electroplating cell is one which operates at a current efficiency of one hundred per cent, has a low resistance, and which requires but a low electromotive force. With a current efficiency of one hundred per cent no change in the condition of the electrolyte will occur. The nickel-plating cell, as at present used, is notably inefficient when viewed from this standpoint. To operate a nickel-plating cell at maximum efficiency, the electromotive force required to send a current through would be only that necessary to overcome the resistance of the electrolyte. There is, however, a counter-electromotive force amounting in some cases to over two volts. The author described a series of experiments which he had carried out with a view of determining the variation of the counter-electromotive force, using for this purpose a slightly acid nickel ammonia sulphate solution. From the results of the work it is shown that satisfactory operation of a nickel-plating solution depends to a large extent upon the character of the anode employed. The presence of copper is advantageous to a certain extent, and it is likely that certain other impurities may assist. Rolled nickel or electrolytic nickel anodes are unsatisfactory. A study of the total polarization pressure, while not as definite in the indications as a study of the individual electromotive forces at the electrolyte, will serve as a means for determining whether the cell is operating properly. When the polarization goes much above 0.75 volt, the assumption that the anode is not corroding properly is justified, and, on the other hand, if the polarization is below 0.70 volt, the efficiency at the anode is as high as can be obtained. For measuring this polarization a voltmeter only is needed, readings being taken while the current is flowing and immediately after opening the circuit.

Discussing this paper, Mr. Johnson doubted if the ordinary plater would be willing to install the expensive apparatus necessary for measuring single electrode potentials. He thought that not enough analyses of the electrolyte had been made in the work described.

Professor C. F. Burgess said that while analytical data was desirable, time had not been available for obtaining this, and, moreover, it was beyond the scope of the paper. As to measuring the electrode potentials, all that was necessary was a calomel cell and a capillary potentiometer, neither of which was expensive nor too delicate for practical use.

President Richards suggested that the impurities might be of assistance in keeping the percentage of nickel in solution up to normal on account of the local action. In this suggestion Mr. Rudolf Gahl did not agree.

Dr. Pedro G. Salom, of Philadelphia, Pa., described the new type of electrolytic cell. In a previous paper he had described his cathodic reduction process for obtaining lead from galena and the cell developed for this purpose. With the old type of cell 10,000 units would have been required for an output of ten tons per day. To overcome the disadvantages of this cell—which were, of course, the small output for the large capital outlay and space required—he had developed a new type of cell which was described and illustrated. In the old type of cell a current density of twelve amperes per square foot had been used. In the new type, by spreading the ore in a very thin layer, he was able to increase the current density to thirty amperes per square foot, and he hoped soon to reach sixty without reducing the efficiency, which he said was now sixty per cent. The time of treatment has been reduced from five days to an hour and a half. The new cell, which measures four and one-half feet, consists of a flat circular dish of lead; which composes the cathode. This is revolved by means of a pawl and ratchet, making one complete revolution in an hour and a half. Above this are suspended the anodes, consisting of horizontal flat bars arranged in a series of compartments, the number of bars being greatest at that part of the cell where the ore enters, and lowest where the treatment is completed. The ore is fed in at present by hand, and is carried by the motion of the cathode slowly around under the anode bars. The electrolyte is sulphuric acid. Hydrogen sulphide is given off, and this is caught and converted into sulphuric acid. The lead sponge is taken out after it has completed the run. It is then washed to remove impurities. At present the sponge is being roasted to convert it into lead oxide. After roasting it is ground and dried and is then ready for the market. The present equipment consists of seventeen cells in one row. In the complete equipment there will be thirty-four cells in each unit. One hundred cells will have a capacity of ten tons per day. Samples of the products of the process were exhibited. These included sponge lead, sulphuric acid, oxides of lead, and chrome yellow.

A paper by Dr. C. Hambuechen, entitled "The Electrolysis of Sodium Hydroxide by Alternating Current," was read by Professor C. F. Burgess. It is well known that aluminum in certain solutions possesses to a marked degree the property of readily permitting the passage of current toward it, and interposing a higher resistance to the flow of current in the opposite direction. This property has been made use of in an electrolytic rectifier, using aluminum and iron electrodes in fused sodium nitrate. It was found also that aluminum could be used in a like manner in various other fused electrolytes, one of which is sodium hydroxide. While aluminum is actively corroded by sodium hydroxide in the presence of water, it is almost completely stable in contact with the fused salt. Advantage has been taken of this property of aluminum to make use of alternating currents for the production of metallic sodium from fused caustic soda. Salt is fused in an aluminum vessel. Within this is placed an aluminum electrode surrounded by an iron electrode. Between the two is a diaphragm also of aluminum. This is perforated so as to allow the circulation of the electrolyte and passage of the current. After some time globules of fused sodium appeared on the surface. It was found that careful regulation of the temperature was necessary to produce a large yield, but other than this the cell required no attention. At the end of the run the aluminum electrode showed almost no corrosion. A run was made to determine the amount of corrosion, and it was found that an electrode one and one-half inches long and one-half inch in diameter lost about one-half of a gramme with a run of fifty ampere-hours. Sodium, after being liberated, rose to the surface of the liquid and was prevented from diffusing over to the cathode by means of the aluminum diaphragm. A porcelain sleeve surrounding the aluminum electrode prevented short-circuiting between this and the diaphragm. To determine the effectiveness of the aluminum in preventing the current flowing from it to the electrolyte, current and pressure curves were obtained by means of the Blondel oscillograph. These curves were shown. The portion of the curve below the axis represents a leakage current due possibly to small particles of sodium adhering to the electrode, and to a small leakage which naturally takes place in such a cell. This portion of the curve represents energy loss, unless its heating action is useful in maintaining the cell at the proper temperature. The portion of the curve above the axis represents the useful current. From measurements of these areas the

efficiency was found to be about seventy-three per cent. The alternating-current electromotive-force wave had a peaked form, but previous measurements showed that a sinusoidal or flatter wave-form gave a higher efficiency. The same method of operating an electrolytic cell might be applied in obtaining various electrolytic products other than sodium. While the current efficiency is less than if a direct current be employed, this loss may be partially balanced through avoiding losses of the synchronous converter, and this loss may be useful in heating the cell.

President Richards then presented a paper prepared by himself and Mr. W. S. Landis, entitled "The Electrolysis of Water." This is the second paper on this subject, the previous one having been presented at the last meeting of the society. The type of cell described in the first paper was very inconvenient due to its great length, but by reducing the cross-section of the cell they have been able to obtain the desired high resistance with a much shorter tube. The cell now used consists of a capillary tube connecting the two vessels in which are placed the platinum electrodes. It was found that the size of the electrodes affected the readings very greatly. When these were small polarization took place rapidly. The area finally adopted was approximately twenty-five square centimetres to each electrode. Solutions of sulphuric acid of various concentrations were measured, the results of measurements being shown in tabular form and in curves. It was found that the current flow followed almost exactly Ohm's law up to three volts, beyond which point the readings were not carried. The resistance of the cell is very high, being about 284,000 ohms for a one-tenth per cent solution. In measuring the current flow, polarization was corrected for by taking the readings at a definite time after closing the circuit. After obtaining the reading the circuit was then opened and the polarization current read after the same time had elapsed as in the first reading. This time was generally seven seconds, as that allowed the instruments to become steady. The sum of these two readings was then taken as the true value, as it was found that this method gave a constant flow, independent of the time elapsing after closing the circuit. Although no gas was given off at the electrodes during this work, gas will be given off at either pole if the electrode there be small, although there may be no gas appearing at the other. It is suggested that this method of measuring resistances might be useful in place of the Kohlrausch method.

After the reading of this paper the meeting was adjourned.

The afternoon was spent in making visits to the various establishments at Niagara Falls, and in the evening a dance and reception were tendered to the visiting members of the society by the local members.

SATURDAY, SEPTEMBER 19.

Saturday morning the third session was called to order by the president at 9.30.

Mr. F. Lidbury, of Niagara Falls, N. Y., presented a paper on "The Supposed Electrolysis of Water Vapor." This described some researches which he had carried out upon the electrolytic action of sparks when passed through a water vapor. The apparatus consisted of an arrangement of glass tubes and the current of vapor was made to pass by means of a condenser. The gases from the neighborhood of the anode and cathode and from the middle of the tube are collected after exploding by means of an electric spark, and a residue of gas was left which corresponded approximately to what should have been produced by a voltameter. The conclusion was reached that in the partial decomposition of water vapor by the electric discharge, the hydrogen and oxygen liberated tend to separate and to take up different positions in the tube, the hydrogen collecting at both anode and cathode and the oxygen in the middle of the tube. In all cases there was a large excess of both hydrogen and oxygen in the discharge tube over that simultaneously obtained from the voltameter. At present there is too little data for the construction of a satisfactory theory to explain the results obtained, but Thomson has brought forth evidence which points to the possibility that a hydrogen ion may carry either a positive or a negative charge. He observed that a capillary tube containing hydrogen, on the passage of a spark, gave spectra at the anode and cathode in which the relative brightness of the lines differ. An assumption of this kind might explain the unexpected behavior of hydrogen as explained above.

A communication from Dr. E. A. Byrnes, of Washington, D. C., entitled "A Note on Metallic Diaphragms," was read by Mr. C. P. Townsend, New York city. The diaphragm was constructed of magnetite. This material, mixed with Portland cement, had been used in melting sodium hydroxide in 1896. It was found that it made a satisfactory diaphragm for aqueous solutions of caustic alkalies when crushed and contained within wooden partitions. It did not act as a bipolar electrode.

Dr. E. F. Roeber, of Philadelphia, Pa., then read a paper entitled "The Theoretical Properties of Free Ions in Solutions." This paper formed the introduction to a discussion of the electrolytic dissociation theory which followed it. Dr. Roeber discussed the theory generally. He said that those who objected to the dissociation theory did not look at the matter in the proper light. The theory, as developed, should be considered merely as a mechanical analogy which assisted the mind in forming a conception of what was taking place in an electrolyte. Viewed in this light the theory had done a great amount of good, and while there were many phenomena which were not explained by it, still its value as a tool is too great for it to be discarded. The proper view to take was that the dissociation theory is only a model to give a concrete conception of electrolytic action.

Dr. Bancroft then opened the discussion by stating what had been accomplished by the dissociation theory, and he gave a long list of the phenomena explained by it. When proposed, it had taken the chemical world by storm. More recently two lines of work had been followed out. One set of investigators are searching for results to uphold the theory, the others looking for its limitations. Both sides have accumulated a great mass of evidence. Against the theory it may be urged that it only applies to infinitely dilute solutions, such as are never obtainable practically, and it applies only to aqueous solutions. He believed that the theory would hold until another and better one was brought forward, and pointed out that abnormal molecular weights may be explained by the heat of solution or some other corrective term, and as a matter of fact we do not know that any dissociation really takes place.

Professor Carhart said that the theory had proved to be a very useful working hypothesis. It had led to many discoveries and facts, and until it has been disproved it must be retained as useful. However, the objections to it can not be ignored and some of these are serious. He thought that the term "electrolytic dissociation" was unfortunate. It should be merely the "dissociation theory," as dissociation of a salt is supposed to take place upon passing into solution. An important point involved is that of the question of energy. The theory was not well sustained by quantitative work. It

is now going through changes and it is not to be disposed of yet, although it has been worked too hard.

President Richards asked whence the energy causing dissociation comes from. This was not explained by the theory. He thought that ionization is a change of state of the materials as a compound. He then discussed the heat of ionization and suggested that this was merely the heat of condensation of vapor. A calculation of this latter point seemed to show agreement with the suggestion.

Mr. W. S. Weedon, of Schenectady, N. Y., said that while ionization might not mean complete separation of the ionization, the state of the compound in solution must differ from the usual chemical state.

Mr. Cowles stated that in studying the energy relations the energy of the whole mass—solvent and solute—should be considered collectively.

President Richards thought that no energy was lost or gained during ionization, and was asked by Dr. Carhart what, then, was the change? He replied that he did not know.

A paper by Mr. Reed, entitled "Berthelot's Law Relative to the Electromotive Forces of Cells Based on the Reciprocal Action of Saline Solutions and Soluble Electrolytes," was read, and, on motion of Mr. Hering, a vote of thanks was tendered to the local committee, to the Niagara research laboratories, to the National Battery Company, of Buffalo, N. Y., to the Niagara Falls Power Company, and to the Niagara Hydraulic and Manufacturing Company, these companies having extended invitations to the society to visit their establishments. The convention then adjourned.

During the afternoon a number of the members of the society visited the plant of the National Battery Company, at Buffalo, and others took a trip to Niagara-on-the-Lake, Youngstown and Port Niagara, by boat and trolley.

There was a good attendance of 136 members and guests out of a membership of about 600. Among those in attendance were the following:

Joseph W. Richards, Bethlehem, Pa.; C. J. Reed, P. G. Salom, Carl Hering, Philadelphia, Pa.; Wilder D. Bancroft, Ithaca, N. Y.; C. L. Collins, 2d, Charles M. Hall, Niagara Falls; E. A. Colby, Newark, N. J.; Alois von Isakovics, New York city; Francis A. J. Fitzgerald, Niagara Falls; A. A. Knudson, Wm. Hand Browne, Jr., New York; C. F. Burgess, Madison, Wis.; Dr. George P. Sholl, Philadelphia; Orrin E. Dunlap, Niagara Falls; Alfred H. Cowles, Cleveland, Ohio; Henry S. Carhart, Ann Arbor, Mich.; G. E. Cox, Niagara Falls; A. E. Kennelly, Cambridge, Mass.; B. J. Arnold, Chicago; Charles F. Scott, A. J. Wurtz, Pittsburg, Pa.; S. W. Stratton, Washington, D. C.; Henry G. Morris, Philadelphia; J. S. Crider, Cleveland, Ohio; W. E. Goldsborough, Lafayette, Ind.; Elihu Thomson, Swampscott, Mass.

American Electrotherapeutic Association.

The thirteenth annual convention of the American Electrotherapeutic Association was held at Atlantic City, N. J., September 22, 23 and 24. The Hotel Windsor was the headquarters of the convention, and a large number of members was in attendance. A splendid list of subjects was presented for papers and discussion. Two sessions were held each day, and there was a number of special features for the entertainment of the delegates.

International Congress of Electricity.

A meeting of the committee on organization of the International Congress of Electricity, which is to be held during the week beginning September 12, 1904, at St. Louis, in connection with the Louisiana Purchase Exposition, convened at Niagara Falls, N. Y., September 18, during the meeting of the American Electrochemical Society. The executive committee was in session the greater part of the day, and transacted much business pertaining to the plans of the congress. Later on the advisory committee was called in to consider matters concerning the relation of the various scientific and technical organizations to the congress.

Among those present at this meeting were the president, Elihu Thomson; vice-presidents, H. C. Carhart, C. F. Scott, W. E. Goldsborough and W. S. Stratton; secretary, Dr. A. E. Kennelly; the treasurer, W. D. Weaver; forming the executive committee and of the advisory committee, Messrs. B. J. Arnold, A. H. Cowles, C. Hering, J. W. Richards and A. J. Wurts.

"The Deterioration of Incandescent Gas Mantles While Burning" was made the subject of a lengthy paper last winter before the Michigan Gas Association by Mr. Alfred H. White, director of chemical technology University of Michigan, and Mr. M. E. Mueller. The principal conclusions arrived at by the authors were: the greatest cause of the gradual deterioration is the loss of cerium oxide, which slowly volatilizes in the intense heat. Experiments on mantles containing originally more than one per cent of cerium indicate that their efficiency increases until the cerium content of the hot zone has dropped to about one per cent, and that from that point on they deteriorate. The rate of deterioration of commercial mantles varies greatly, but the important factor is still the decrease in the percentage of cerium. Some mantle manufacturers are able to very greatly lessen the rate of loss of cerium, and thus make mantles which retain their efficiency for long periods. The experiments do not support the theory of periodic change in the mantle's illumination, but confirm the position previously taken that the alteration of the heating power of the gas, with its consequent effect on the temperature of the mantle, is the most important factor in causing the fluctuations in the illuminating power of a mantle from one day to the next. The amount of moisture in the atmosphere also exercises an appreciable influence.

BOOK REVIEW.

"Electrical Engineering." E. Rosenberg. Translated from the German by W. W. H. Gee and C. Kinzebrunner. New York. John Wiley & Sons. Cloth. 267 pages. 6 by 9 inches. 263 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

This book gives the construction and the principles of operation of alternating and direct-current generators and motors, accumulators, converters, and lightning arresters. It also has chapters on electric lighting, polyphase apparatus, and the working of dynamos in parallel. The author, who is the engineer of a prominent European manufacturing company, conceived the book while preparing a number of lectures to be delivered before workmen of the manufactory. The author's style is admirably suited to this class of readers. No mathematics is employed except arithmetic in a few numerical problems and the various expressions for Ohm's law. A treatment of alternating-current subjects, without the use of mathematics, is of necessity imperfect and therefore this book will be found unsatisfying and inadequate to the needs of those students who are mathematically equipped. On the other hand, the extensive engineering knowledge of the author has filled his book with interesting and suggestive statements of facts and details, which will be of value to those who are already familiar with the principles of the subject. The pieces of apparatus which are employed as types for purposes of illustration have a foreign look. The book ought to find a field among those who are forced to self-study.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Recording Wattmeters for Alternating-Current Circuits.

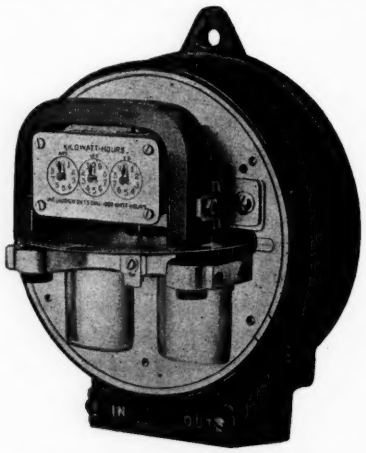
The accompanying illustrations show a new form of recording wattmeter for alternating-current circuits which has been developed by the Stanley Instrument Company, of Great Barrington, Mass. The significant features of this wattmeter, and for which special merit is claimed by the manufacturer, are light weight of the moving parts, perfect spring support, high effective torque, no change, braking air-gap by temperature, complete magnetic shield against short-circuits, balanced thrust, no kicking or pusher auxiliary friction devices, and no jewel wear from hammering or side thrust. The instrument, the company states, ranks next to its magnetic suspension wattmeter.

In this wattmeter the side thrust toward the centre of the disc of the meter is counterbalanced by closed circuited copper rings placed over the side of the field or shunt pole nearest to the edge of the disc. The result of this construction is that a thrust is set up across the field pole in the opposite direction to that produced by the eddies in the disc. This secondary or opposing thrust is so proportioned that it counterbalances exactly the side push.

Special care has been taken by the designers of the Stanley wattmeter to determine the causes of all manner of friction and wear on the bearings, or any magnetic influence which tends to produce error in the operation of the meter. Counterbalancing principles have been employed, so that the only element of friction existing in the balanced thrust wattmeters is that due to the simple rubbing of the very small end of the disc and shaft upon the surface of a highly polished jewel. The employment of special features and the elimination of kicking or other auxiliary devices have done away entirely with vibration, hammering, trembling, side thrust or side dipping or slanting.

The shunt and series system of the wattmeter is enclosed in an iron box forming the back of the case of the meter, which is entirely covered by the magnetic shield. The magnetic shield constitutes the division plate between the back and the front of the meter. Upon the front of the magnetic shield plate is mounted the disc shaft and its bearings, the brake magnets and air-gap adjusting screws, the train gearing and dial, and also the clamp wherewith the disc shaft is supported from its lower bearing during transportation.

The air-gap or distance between the disc and the brake magnets can not be changed by variation of temperature, as the brake magnets are held rigidly in a



COVER REMOVED, RECORDING WATTMETER FOR ALTERNATING-CURRENT CIRCUITS.

permanent position, so that they can not expand or contract. The air-gap can be changed only by means of large adjusting screws placed in the yoke below the disc, for the purpose of adjustment of the rate of disc rotation.

The method of sealing shown is by pass-

RECORDING WATTMETER FOR ALTERNATING-CURRENT CIRCUITS, SHOWING METHOD OF SEALING.

ing a thin wire through a hole in the head of each screw holding the terminal box cover in place; then through a hole in the rim surrounding the head of each screw fastening the main cover in place and through the slot in the head of each of those screws, finally fastening the two ends of the sealing wire in a lead seal crimped together in the usual manner. This method can be modified in various ways at the pleasure of the company using the meter. When so sealed the meter will be dust-tight, air-tight, moisture-tight and insect-tight; its condition can not thereafter be disturbed without breaking the sealing wire and thereby disclosing that it has been tampered with.

The disc shaft, when in place for rotation, rests upon a finely polished, carefully selected jewel, mounted in a carrier supported on a most accurately graduated spring; the whole arrangement of jewel, carrier and spring being immediately in sight and most readily accessible for adjustment or replacement if such ever becomes necessary.

Although elimination of hammering and side thrusts is thoroughly effected by the design of meter and a spring-supported jewel carrier is not at all a necessary requirement, except in places where there is excessive exterior vibration, the balanced thrust wattmeter is provided with a method of spring support adjustment which is most unique, simple, sensitive and sturdy. For transportation and handling, the shaft is lifted and held fast by a clamp to prevent injury to the jewel by heavy jar; it is readily released when meter is in place ready for service.

The cover of the standard model H Stanley balance thrust wattmeter will be all glass, in one piece, through which will be visible all the parts seen in the illustration herein of meter with cover removed.

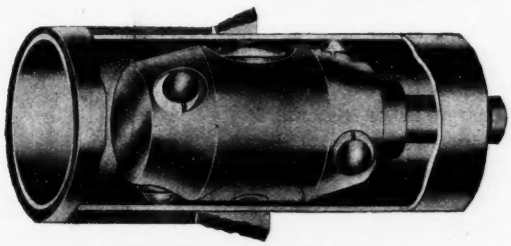
The glass cover will be thick and of strong and tough material, not easily liable to fracture; it will be secured to the iron case in the same manner as the metal cover, embedded on a gasket and making an air and dust-tight joint; it will be sealable in the same manner as the metal cover.

The model H Stanley balanced thrust wattmeter is small and compact, being but seven inches diameter, five inches high and weighs but about twelve pounds; in every detail of construction it is made in the very best possible manner; every requirement of the highest class meter has been considered and supplied.

An innovation in the line of railroad telegraph service has been put into use on the New York Central Railroad between Utica and Albany. By the means of the apparatus a single wire can be used for telegraph and telephone messages at the same time. While the operator is ticking away a telegram in Morse code another person can telephone a message without the slightest interference.

A New Form of Boiler Cleaner.

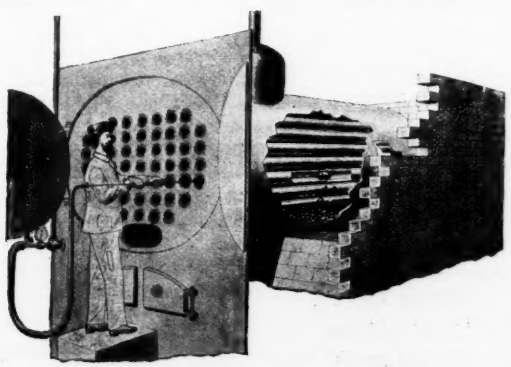
The importance of preventing or removing all scale formations from boilers for reasons of both economy and safety is so well established and the difficulty of accomplishing it so well known, that every advancement in this department of engineering is of pecuniary, as well as humane, interest to both the man who pays the coal bills and the engineer in charge of the power plant.



NEW FORM OF BOILER CLEANER.

Innumerable devices and means have been invented to prevent the formation of scale in the boiler and on the whole conditions have been generally improved. Still in the light of our present knowledge, it may well be doubted whether any practical means can be devised that will positively ensure the user against the presence of scale in the boilers.

The net result, therefore, is that from time to time the scale that has formed must be removed either by entering the boiler and chipping it off by hand, or using some mechanical contrivance for doing the same work.



METHOD OF USING BOILER CLEANER.

To any one at all familiar with the construction of the boiler of to-day, especially of the return tubular type, where the scale forms on the outside of the tubes, the impossibility of cleaning the tubes of this scale by hand is at once apparent, and is the chief reason for the great favor into which mechanical cleaners have sprung with the trade. The inspection of this form of boiler is so difficult that scale is very often present without being known by the engineer.

The construction of a return tubular boiler is such that all these mechanical cleaners have taken the form of some device or machine which has entered the tube, and has a knocker or rapper that may be operated by hand or power, so as to rap or hammer on the inside of the tube sufficiently hard to jar the scale from the outside.

A careful study of the problem at hand has clearly shown that the most effective and least dangerous method of rapping the tube consists in having the highest possible number of raps in a given time, which otherwise may be comparatively light blows, the effect of which will be to set up a more or less local, but very rapid, vibration to the walls of the tube, which by reason of the more brittle and non-elastic character of the scale formation breaks up, loosens and shakes off the latter, without subjecting the tube to any undue strain.

Keeping these points well in mind the General Specialty Company, of Buffalo, N. Y., has devised a machine in which the motive fluid is applied in the most direct manner, thus ensuring the greatest speed of piston, and the double-acting knocker rod, which is firmly secured to the former, in which the travel of the knocker rod is so limited that though it is capable of exerting a sufficiently hard blow on the tube, it could not puncture or injure it, because even though the tube were not present to stop the motion of the rod, it would not travel beyond the point where the walls of the tube would be. This construction makes it possible to safely operate the machine at boiler pressure, thus obviating the necessity of using a separate steam gauge or reducing valve to lower the pressure.

For obvious reasons the body of the machine must be made considerably smaller than the inside diameter of the tube, and this, in connection with the rest of the construction, necessitates some means for accurately maintaining the machine in the axis of the tube. This is accomplished by two sets of centering lugs, one ahead and one back of the piston, which are forced out against the inner surface of the tube by steam pressure.

The undue heating of the tube operated on is further avoided by so using the steam that it is expanded to such a point before exhausting into the tube that its temperature is only a very little above that of the atmosphere.

An actual test of this machine showed a speed of 3,000 strokes and upward per minute, according to the pressure used, nor was the temperature of the tube at the end of thirty minutes raised so much but what it could be easily handled without gloves.

The illustrations appearing herewith show the cleaner in operation. Further information can be procured from the manufacturer, the General Specialty Company, 705-711 Seneca Building, Buffalo, N. Y.

A New Record for Wireless Telegraph.

The De Forest Wireless Telegraph Company has recently made out a summary of the work done for Sir Thomas Lipton, on board his steam yacht Erin during her stay in American waters. During the seventy-three days that the yacht was in New York waters, almost constant communication was maintained with the De Forest stations at Coney Island, State street, New York, and Block Island. The bulk of the matter transmitted was personal correspondence of Sir Thomas Lipton, and comprised 2,000 individual messages, footing up a total of over 40,000 words, and in addition 130 cable messages all in cipher code. A total of 10,750 words were transmitted for the press, for which a collection of $25 per day was made. The average length of a message was twenty words, and frequently a message ran as high as ninety words, from which it will be seen that in this case the De Forest system fulfilled very nearly the function of the telephone. To transmit this bulk of

business it was necessary to send at an average speed of thirty-two words per minute. In length of time, speed, transmission and accuracy, under every imaginable condition, weather and distance, this service certainly makes an enviable record. Sir Thomas has sent the following letter to Dr. De Forest:

S. Y. ERIN,
NEW YORK, 11th Sept., 1903.

DEAR DOCTOR DE FOREST.

It gives me great pleasure to speak a good word for the working of the De Forest wireless system, which was installed on my yacht Erin in Glasgow last May.

The system has been of great use and value to me, and my guests, since my arrival in this country on the 24th June, from which time up to the present it has been in use. As many as ninety messages in a day have been sent and received on the Erin.

Many prominent visitors have made use of the system, among them being Adjutant-General Corbin, the Earl of Shaftesbury, J. H. Flagler, Paymaster General Bates and many others. I, myself, have used the system very extensively, not only for inland messages, but also for the sending and receiving of many cables from all parts of the world. Many of these cables have been in cipher code and, without exception, all have been sent and received correctly. I believe the day will come when every ship will have wireless telegraph on board, and I shall take pleasure in strongly recommending the De Forest system. Its use can only be appreciated by those who have tested it, as I have done for a period of over eight weeks.

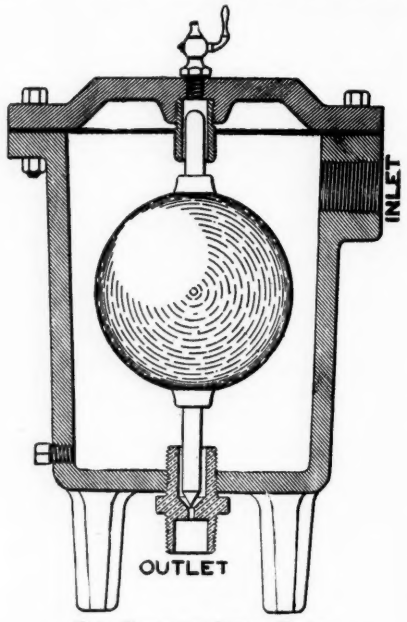
I am, yours faithfully,
(Sgd.) THOMAS J. LIPTON.

DR. LEE DE FOREST,
100 Broadway,
New York city.

This installation on a private yacht, and its performance, should augur well for its general adoption by this kind of craft.

A New Form of Steam Trap.

The "Monash" steam trap made in five sizes for high or low pressure embodies many advantages over the ordinary steam trap. Persons who have had the opportunity of acquainting themselves with steam plants will be able to appreciate the advantage of having a trap which is positive in its action (which the manufacturer claims for the "Monash" trap), thereby doing away with the pounding in the steam pipes due to the steam coming in contact with the water, which was there because of the trap not working. The "Monash" trap, illustrated herewith, is said to be the simplest steam trap on the market, being made of but three pieces, body, float and cover. This trap, it is asserted, is always ready for work and no adjustment is required. The manufacturer claims that the "Monash" trap never fails to act perfectly as the float is held in a central position by the steam and therefore obviates the possible chance of sticking. The operation of this trap is as follows: When the float is at the bottom position, as shown in the illustration, the valve at the outlet is closed, water enters the trap at the inlet and gradually fills the trap about two-thirds full, at which point the buoyancy of the float overcomes its gravity and any pressure tending to hold the valve at the outlet closed. The float then rises, thereby permitting the accumulated water to pass through the outlet. When the water in the trap has been discharged to a point about three inches from the bottom, the float will have sunk so that the steam will close the outlet opening and the trap begins to fill again. A certain quantity of water always remains in the trap, thus preventing the discharge of any steam. The floats are of copper manufactured by an electroplating process and are



NEW FORM OF STEAM TRAP.

tested under a hydraulic pressure of 600 pounds to the square inch. This trap is made by the Monash-Younker Company, 45 Centre street, New York city, and 207 South Canal street, Chicago.

Dam to Give Chicago Power.

The business interests of Chicago, Ill., and the small manufacturing towns along the drainage canal even further south than Joliet will be greatly benefited if the plans of the Sanitary Board are carried out. The first step to bring this about has been taken by the Sanitary District of Chicago filing a petition for the condemnation of land in Lockport township for the construction of a water power plant utilizing the flow in the Chicago drainage channel. The board is planning to drain the water and transmit the power to Chicago and the other towns for electrical illumination and other purposes.

Westinghouse Electric and Manufacturing Company's Balance Sheet.

A comparison of the last balance sheet, issued in 1897, which the Westinghouse Electric and Manufacturing Company has recently published in connection with the application for listing new stock, shows a decided gain in financial strength, as reviewed by the *Wall Street Journal*.

Working capital, or the balance of current assets over current liabilities, is now $12,134,395, compared with $2,093,146 in 1897, an increase of $10,041,249. This does not include stocks and bonds in the treasury, which have increased from $5,964,879 in 1897 to $7,251,385 in 1903. These securities are carried at cost.

The company's fixed assets, including property and patents, have increased from $7,816,089 in 1897, to $13,577,701 in 1903, a gain of $5,761,612. Besides this, there has been written off, according to one of the reports, $2,786,719, indicating a total expenditure of $8,548,331.

In 1901 $3,000,000 stock (par $50) was issued at $55 a share; and now $4,500,000 is being issued at $80 a share. When the new stock will have been issued, total capital increase in the six years will have amounted to $10,853,000 (par value), and $3,865,000 proceeds from stock to issue is still to be added to working capital.

The surplus after dividends for the six years may be figured as follows:

Gain in working capital	$10,041,249
Gain in stocks and bonds owned.	1,286,504
Gain in fixed assets	8,548,084
Total gain in assets	$19,876,084
Stock and bonds issued (less retired) par value	6,353,711
Balance	$13,522,373
Less premium on stock sold	1,551,000
Balance, surplus earnings	$11,971,373

This amount is probably not far from the actual amount of earnings after dividends and interest since 1897.

The gain in working capital is a reflection of the rapid growth in the company's business. This growth may be seen in the following figures of gross sales for the years ending March 31:

Year.	Sales.
1898	$4,378,060
1899	6,901,760
1900	11,963,646
1901	15,853,481
1902	19,975,958
1903	23,899,492
Total sales, six years	$82,972,397

Twenty per cent of the above total gross sales would be about $16,500,000, which is probably the amount of net earnings before dividends and interest.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

POWER FOR WASHINGTON—The War Department has formally approved plans for the long proposed dam in the Potomac river at Great Falls. Work is to be begun at once by the Great Falls Electric Power Company, which is to supply the City of Washington with power for electric lighting and for its street railways and other institutions.

PENNSYLVANIA RAILROAD SHOPS TO BE ELECTRICALLY DRIVEN—Announcement has been made that the new shops of the Pennsylvania Railroad Company at Wilmington, Del., will be equipped with electric motors throughout. Each machine which requires power will be furnished by a small independent motor which will be directly under the control of the man running the machine. Power will be furnished by the power-house which is being erected, and will be conveyed to the motors by distributing wires.

TO TUNNEL UNDER NATIONAL CAPITOL—The district government at Washington on Wednesday, September 8, granted the formal permit to the Pennsylvania Railroad to construct the twin tunnel under the United States Capitol and the adjacent blocks and streets, electricity being agreed upon as the motive power. The tunnel will be 3,000 feet long, beginning at the intersection of Massachusetts avenue and First street, northeast, going under Capitol hill to New Jersey avenue and D street, southeast. The total cost of the work will be approximately $800,000.

KANSAS CITY TELEPHONE RATE LITIGATION—The ordinance compelling the Missouri-Kansas Telephone Company to reduce its rates for business and residence telephones from $96 and $60, respectively, to $60 for business telephones and $36 for residence telephones, has been upheld by T. J. Smith, of Butler, Mo., the referee appointed by the Supreme Court to hear the evidence in the company's contention that the measure was unreasonable and practically meant confiscation. The referee's finding means apparently that Kansas City has the right to regulate telephone rates for local service. The Supreme Court will convene in October, when it will pass upon the findings of the referee.

NEW POWER PLANT FOR MICHIGAN—Plans for a new hydroelectric plant on the Huron river, near Rockwood, Mich., are in process of completion. Mr. M. R. Bacon, of the Michigan Alkali Company, Wyandotte, and Frank Nellis, of Wyandotte, are said to be the prime movers in the project. The capitalization of the company will be from $200,000 to $500,000. The erection of a water power plant on the Huron, the power to be furnished by the river, with the aid of a large dam, is contemplated. At the location in view the river is less than 100 feet wide and about six feet in depth. It is said that the construction of the dam is designed to raise the depth of water to ten or twelve feet. Contracts will probably be made to furnish power to run the electric cars of the Detroit & Toledo Shore Line.

THE EARNING POWER OF THE NEW YORK & BROOKLYN BRIDGE—Commissioner Lindenthal has recently made an estimate of the earnings of the New York & Brooklyn Bridge. He expects that the profit for next year will be $35,000. It is expected that $77,000 will be collected in roadway tolls and $65,000 from trolley cars. The elevated railroads will pay $90,000 for their use of the bridge. Real estate rented in the terminal structures will bring $90,000 to the city treasury, and the companies laying wires on the bridge will pay $8,000 for the privilege. The mail tube across the bridge brings $1,000 a year to the city. The total receipts are estimated at $357,000, and the expenditures, including salaries of $52,000 and payrolls of $210,000, are put at $322,000. No estimate is made of the interest on the investment, which would not show a profit if this item were reckoned in.

NEW NIAGARA POWER LINES IN OPERATION—Current was transmitted for the first time to a consumer over the new lines of the Niagara Falls Hydraulic Power and Manufacturing Company at 8 o'clock Monday morning, September 14. The transmission line feeds the north end industrial district of Niagara Falls. The Carter-Crume Company, of Niagara Falls, is the first consumer on the new transmission line. The new three-phase generators which are to supply the new transmission line with power were built by the Bullock Electrical Manufacturing Company, of Cincinnati, but the new switchboard which has been installed at the power-house is the work of the employés of the company themselves. The transformers were furnished by the Westinghouse Electric and Manufacturing Company and the cables by the National Conduit and Cable Company. The transmission line is one of the finest pieces of work of its kind ever done in this vicinity. The poles are of cedar and were brought from Idaho.

SOUTH AFRICAN POWER PLANT—Contracts are to be let for the power-house and equipment for an extensive electric traction system to be constructed in Johannesburg, South Africa. Bids are to be received by the British electrical engineering firm of Mordey & Dawbarn. There are two sets of specifications, one calling for steam engines and the other for gas engines to operate the road. The boiler capacity of the plant will be somewhat over 10,000 horse-power. The specifications for the gas plant require a gas-producing plant capable of gasifying seven and one-half tons of coal per hour, with coal-conveyor and cleaning and cooling plant and accessories; four gas engines, each to drive a 1,350-kilowatt dynamo; three gas engines, each to drive a 650-kilowatt dynamo; three gas engines, each to drive a 675-kilowatt, two-phase, alternating-current generator; two motor-generators, each consisting of a 250-kilowatt, two-phase alternator; two dynamos of 150 kilowatts capacity each, and two 450-kilowatt dynamos. The specifications for the steam generating plant comprise four water-tube boilers of 10,000 horse-power, with conveyors, automatic stokers, economizers, condensing plant, engines or turbines and electric generators and motors.

ST. LOUIS LIGHTING MERGER—A certificate of incorporation for the new Union Electric Light and Power Company, of St. Louis, has been issued by Secretary of State Cook and filed with the recorder of deeds in St. Louis. At a meeting of the board of directors, held recently, it was voted to combine the two companies—the Missouri Edison Company and the Union Electric Light and Power Company—under the latter name. Most of the officers of the old Union Electric Light and Power Company were retained as officers of the new corporation. The only changes were in the election of a new first vice-president and the creation of two new offices, those of second vice-president and assistant secretary-treasurer. C. W. Wetmore, of New York, succeeds Charles W. Walsh as first vice-president. William F. Nolker was made second vice-president, and Sherman B. Pike, formerly secretary of the Missouri Edison Company, was made assistant secretary-treasurer. The following new directors were elected to fill vacancies made by resignations: C. W. Wetmore, to succeed C. W. Morath; George R. Sheldon, to succeed S. Pollak; John H. Beggs, of Milwaukee, to succeed John H. Bradelle; and C. E. Thister, of Milwaukee, to succeed Harold P. G. Coates.

TO LAY ALASKAN CABLE—The United States cableship Burnside has sailed from Seattle, Wash., for the north to continue the work of laying the cable from the head of the Lynn Canal by way of Sitka, the capital of Alaska, to Seattle. She has a stretch of 600 miles of cable aboard, which was transferred from the steamship Texan, which brought the cable around Cape Horn from New York. On board the Burnside when she sailed were General A. W. Greely, chief signal officer of the United States Army; Colonel James Allen, of the Signal Corps, under whose general supervision the line will be laid; Captain Edgar Russell and Captain George O. Burnett, of the Signal Corps; Henry Winter, cable engineer; Lieutenant Charles P. F. Chandler, of the quartermaster's department. Captain A. H. Laffin is in command of the vessel. The Burnside proceeds direct to Juneau, where, after making a short line connection, she will start for Sitka, paying out about 250 miles between the two towns, and continuing south

from the capital by the open ocean, as far as the cable rope will reach, possibly to a point off Queen Charlotte Isle. It is expected that the entire consignment of cable on the Burnside will be laid and the vessel be back in Seattle by October 15.

A NEW YORK-BOSTON TROLLEY—Plans have been completed for a through trolley line from New York to Boston, and those back of the project say that it will be in operation within two years. It is probable that several trolley lines now in operation between these two points may be absorbed by the new company, or, at least, an arrangement be made to use some of the tracks of these companies. The object of the new line is to provide through service between New York and Boston, and to have trains equipped with sleeping and parlor cars. The line is to be by way of Worcester, Hartford and New Haven. After the completion of the line, residents of New York and Boston will be able to take this trip between the two cities in only twice the running time of the present steam railroad, and at half the expense. Some trolley sleepers have already been finished for the syndicate, and they are to be tested shortly on a line running from Indianapolis to Columbus. They are said to be the first trolley sleeping cars ever built in this country. S. Harrison Wagner, an attorney for the syndicate, has made this statement: "There is plenty of capital behind the syndicate, and the work of completing the line will go on as fast as possible. I do not know just how far along on the stretch between Worcester and Hartford the construction of the track has been completed, as I have not seen the men of the syndicate in about three weeks. Neither could I say just when the line between Hartford and New Haven will be started. There are some preliminary steps to be taken before the track laying is actually begun. The route between New Haven and Port Chester has not been settled as yet. There will be no trouble from the New York, New Haven & Hartford Railroad because of any running of tracks parallel with the tracks of that company. The New York, New Haven & Hartford withdrew from the legislature the proposition making it necessary to take out a special charter. The electric company will therefore pass through the state under the general railroad laws. As to the road being a three-rail system, I suppose some parts of it will be, but in other places along the line it must be the overhead trolley."

CARS FOR NEW YORK SUBWAY TESTED—The Interborough Rapid Transit Company, the company which will operate the cars in the New York rapid transit subway, tried five of the new subway cars last week on the Third and Second avenue elevated structures, New York city. These cars are apparently unusually substantial in construction. They are four inches lower than the elevated cars, but three inches wider at the bottom and four feet longer, the length over all being fifty feet, one inch over the platforms, and the car body forty-two feet seven inches. The width at the deck eaves moulding is eight feet five inches. The height over top of rail roof is twelve feet. Especial care has been taken to equip the cars in a manner to prevent accident by fire from the electrical apparatus. The floor framing is composed chiefly of rolled steel beams. Over the truck containing the motors a steel plate has been framed in, and on top of this plate is a sheet of one-quarter inch asbestos. Beneath the double maple flooring of the car proper has been placed a sheet of one-quarter inch asbestos fire felt, and underneath the body of the car a one-quarter inch sheet of specially prepared asbestos board called "transite." The wires are insulated with asbestos and are run in hard moulded asbestos forms, so that there are several layers of incombustible material between the wiring and the electrical apparatus and the car interior. The sheathing on the side, which extends from the bottom of the car to the windows, is made of copper sheet, rolled on. The cars carry two lines of air pipes, known as a main reservoir and train line pipe for the automatic brake system. When the train is in motion the main reservoir line is charged with ninety pounds of compressed air to the square inch. The air is compressed by means of electrically driven compressors, which are installed under each motor car. When the train is in motion the train line pressure is so regulated that seventy pounds pressure to the square inch is carried, and any reduction in the train line pressure causes the brakes on the entire train to set automatically and simultaneously. The train line pressure is coupled with the electric controller, and if at any time, while the current is being fed into the motors, the motorman should for any reason take his hand off the controller when the train is in motion, the brakes are at once set on the entire train. Just before the brake is automatically set the current is cut off from the motors on the entire train. This is also done automatically. There are no gates on the cars, but sliding doors and vestibules. These are opened and closed by means of levers. The windows open from the top instead of the bottom. Each train will have eight cars, five of them motor cars and three trailers. Five hundred cars are at present being built. They will run on the Second avenue elevated line during the winter, and the cars now running on that road will be distributed over the other lines. Among those on the initial trip of the experimental car, which was from Third avenue and Ninety-eighth street to Bronx Park on the Third avenue line, and down Second avenue to South Ferry, then uptown again on the Second avenue track, were George H. Pegram, chief engineer of the Manhattan division; C. L. F. Deyo, chief engineer of the Interborough Rapid Transit Company; L. B. Stillwell, electrical director of the Interborough Rapid Transit Company; E. P. Bryan, vice-president of the company; Alfred Skitt, vice-president of the Manhattan division; C. E. Case, assistant engineer of the General Electric Company; W. H. Sawyer, assistant engineer of the General Electric Company; W. T. Thompson, master mechanic of the Subway division; J. S. Doyle, master mechanic of the Manhattan division; Hugh Hazleton, electrical engineer of the Manhattan division; F. R. Slater, H. F. Putnam, John B. McDonald, August Belmont, Walter G. Oakman and George W. Young.

ELECTRIC RAILWAYS.

OTTAWA, ILL.—The Illinois Valley Traction Company proposes to extend its line from Marseilles through to Morris and Joliet as soon as the road between La Salle and Marseilles is completed and in operation.

TUSCOLA, ILL.—The Decatur, Tuscalo & Champaign Railway Company has been incorporated to build a line from Champaign to Tuscola, connecting all intermediate towns. It is said that work will begin at once.

EVANSVILLE, IND.—The Evansville, Boonville & Rockport Electric Company has filed a $10,000 bond with the city treasurer guaranteeing to build its road. The survey is completed and work will begin this fall.

ST. LOUIS, MO.—The county court at Clayton has granted a franchise to the St. Louis & Olivette Railroad Company, for two lines between St. Louis and Olivette. The work of construction is to begin May 15 next.

RICHMOND, IND.—Construction has been begun on the Eastern Indiana Traction Company's road, which will extend from Hamilton, Ohio, to Marion, Ind., passing through Richmond, Fountain City, Lynn, Winchester and Gas City.

HARRISBURG, PA.—The West Fairview & Marysville Electric Railway Company has passed into the hands of the Harrisburg & Mechanicsburg Electric Railway Company, which is controlled by the Cumberland Valley Railroad Company.

PHILADELPHIA, PA.—Articles of incorporation have been filed in the Camden County Court for the Porto Rico Railway, Light and Power Company, with a capital of $125,000. The purpose of the corporation, the articles state, is to build a trolley road from San Juan to Ponce, Porto Rico, and to construct waterworks at several points on that island.

BETHLEHEM, PA.—The New Jersey & Pennsylvania Traction Company, which now has its line running from Newton to Trenton, is rapidly completing plans for extending it from Newton to Willow Grove, and it is thought that the road will be in operation within a year. The line will pass through Richboro, Southampton, Davisville and Hatboro, and connections will be made at Willow Grove with the Rapid Transit Company's system.

HEMPSTEAD, L. I.—It is stated that the Long Island Railroad Company will construct a trolley line from Jamaica to Rockaway Beach, connecting Belmont Park, Springfield, Woodsburg, Cedarhurst, Lawrence and Far Rockaway. It is also stated that the Long Island company will substitute electricity for steam by the end of the year on the Bayside and Port Washington divisions, and that eventually this plan will be followed on all the shorter branches on the island.

ELECTRICAL SECURITIES.

The developments in last week's stock market showed that the bear interests were still in a strongly intrenched position and were meeting with extreme success in forcing prices downward. Such good securities as United States Steel were depressed until the low level of 17 had been reached; but, upon support, this came back to 17½. Prices, compared with a week ago, are generally lower, but it can be said that conditions, on the whole, are not adverse. The bear pressure was distinctly responsible for the decline, and liquidation did not enter into the question as a potent factor. Brooklyn Rapid Transit also was the subject of manipulation, and it seems likely that this stock is being worked by important interests in order to bring about a condition that will ultimately mean the reorganization of the shareholdings.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 19.

New York:	*Closing.*
Brooklyn Rapid Transit	37¼
Consolidated Gas	170½
General Electric	155
Kings County Electric	160
Manhattan Elevated	131⅞
Metropolitan Street Railway	111⅜
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	160

The directors of the Metropolitan Street Railway Company have declared the regular quarterly dividend of 1¾ per cent, payable October 15. Books close September 24 and reopen October 16.

Boston:	*Closing.*
American Telephone and Telegraph	130
Edison Electric Illuminating	230
Massachusetts Electric	80
New England Telephone	124
Western Telephone and Telegraph preferred	80½

The directors of the American Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent on the company's stock.

Philadelphia:	*Closing.*
Electric Company of America	8¼
Electric Storage Battery common	55
Electric Storage battery preferred	55
Philadelphia Electric	6⅜
Union Traction	43⅞
United Gas Improvement	84½

The directors of the Electric Storage Battery Company have declared the quarterly dividend of 1¼ per cent on the common, and 1¼ per cent on the preferred stocks, payable October 1. Books close September 23 and reopen October 1.

The balance sheet of the Philadelphia Rapid Transit Company, as of June 30, 1903, shows total assets of $6,574,424 and liabilities of $6,168,536, leaving a net surplus of $405,888.

The Union Traction Company has issued its balance sheet of June 30, 1903, which shows assets of $17,342,447 and liabilities of $13,269,870, leaving a surplus of $4,072,577.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	145
Metropolitan Elevated preferred	55
National Carbon common	21
National Carbon preferred	88
Union Traction common	5
Union Traction preferred	33

ELECTRIC LIGHTING.

SOUR LAKE, TEX.—The Light and Power Company has completed its plant and the same is now in operation.

HUDSON, OHIO—L. H. Chopin has secured a franchise for an electric light plant for this town.

DES MOINES, IOWA—F. E. Sanders, of Fayette, will erect the waterworks and electric light plant there.

MANCHESTER, OHIO—The streets of Manchester are now lighted by electricity, the new plant having been completed recently.

PERRYSVILLE, OHIO—At a meeting of the citizens it was decided to install an electric light plant for street lighting and other purposes.

ROYERSFORD, PA.—The electric plant of the Schuylkill Valley Electric Illuminating Company, on the south side of the Schuylkill river, at Cromby, has been completed and put in operation.

SPRINGFIELD, ILL.—Work has been commenced on the construction of a large power-house for the Decatur, Springfield & St. Louis electric railway on the Sangamon river. The building will be 400 feet long and will cost $230,000.

AUSTIN, TEX.—The charter of the Amarillo Water, Light and Power Company has been filed with the secretary of state. The company has a capital of $100,000, and the incorporators are W. F. Ramsey, John K. Brydes and L. W. Chase.

ACKLEY, IOWA—The electric light plant in this city has again changed hands, the George C. Wright Company, of St. Paul, Minn., which purchased the property this spring, selling to R. W. Smith, of Cleveland, Ohio, and D. J. Smith, of Central City, Col. The consideration was $20,000.

SPRINGFIELD, MASS.—The Boston & Albany Railroad will install an electric plant at the Union station for furnishing light to its freight yards, signal towers and contiguous yards. Power will be obtained from the Westfield river.

SALT LAKE CITY, UTAH—The Utah Light and Power Company will increase the capacity of its West Temple station from 1,100 horse-power to 2,000 horse-power. This improvement will involve the outlay of $50,000 within the next twelve months, and ultimately a total outlay of $100,000.

DES MOINES, IOWA—Improvements and repairs aggregating $60,000 will be made to the plant of the Des Moines Edison Light Company, work to begin at once. Chief of the improvements planned is the total abolition of the smoke nuisance by the equipment of the furnaces with an automatic device for this purpose.

DANSVILLE, N. Y.—The Dansville Gas and Electric Company has sold its entire plant and business to the Mill Creek Electric Light and Power Company, and the new company has taken possession. New machinery will be put in whereby more power will be furnished, and the electric lighting plant will run all day as well as at night.

MARION, OHIO—The Electric Light Company's plant at Prospect has been sold to the Columbus, Delaware & Marion Electric Railway Company, the consideration being about $10,000. The plant has a capacity of 25,000 candle-power. It will be converted into a power plant for the interurban line and considerably enlarged. The contract for lighting the streets of Prospect and furnishing commercial lights will be carried out by the new owner of the plant.

DETROIT, MICH.—It is stated that capitalists at Wyandotte, a suburb of this city, are about to launch an enterprise that has for its object the development of water power on the Huron river. A company with a capital of $300,000 is being formed for the purpose of erecting a large electrical plant to be operated by power procured from the Huron river. It is said that a contract has been made to furnish electric power to operate the new Detroit & Toledo Shore Line Railway.

WINONA, MINN.—Articles of incorporation of the St. Charles Light and Power Company have been filed with the county register of deeds. The purpose of the organization is the manufacture, distribution and sale of electric current for heat, power and lighting. The principal place of business of the company is to be St. Charles, Minn., and its term of existence is to be thirty years, beginning on September 5, 1903. The capital stock is placed at $12,000, and the incorporators are as follows: M. J. McGrath, of Winona; Charles F. Knapp, Herman Canfield, Thomas Shock and A. G. C. Rabben, of St. Charles.

AUGUSTA, GA.—It is understood that a northern syndicate which is interested in the development of the Anthony shoals property has completed its plans and that work will commence shortly. It is reported that the syndicate has options on over 4,000 acres of property right as a site of the proposed power plant, and that 8,000 horse-power will be developed. The company's first move will be the construction of a railroad from either Middleton or Elberton to the shoals, a survey of which has already been made, and which will later be continued to Tignall, in Oglethorpe County, and then through Lincolnton to Augusta. It is estimated that the dam which the company proposes to erect at the shoals will cost it $17,000, while the canal will cost about $60,000.

PERSONAL MENTION.

MR. S. G. BENTLY, of Chicago, Ill., has been appointed manager of the Postal Telegraph-Cable Company at Chattanooga, Tenn.

MR. E. B. RAYMOND has been appointed general superintendent of the Buffalo plant of the General Electric Company.

MR. H. WHERLAND has been appointed as superintendent of the electric light plant at the University of Minnesota.

MR. L. W. LAWSON has been appointed superintendent of the Washburn shops of the Worcester Polytechnic Institute, Worcester, Mass.

SIR DAVID BARBOUR, Baron Ribbesdale, and several other members of the commission on London traffic have sailed for the United States to enquire into the street railway systems of New York and Boston.

PROFESSOR HENRY B. DATES, professor of electrical engineering at the Clarkson School of Technology, Potsdam, N. Y., has been appointed professor of electrical engineering at the University of Colorado.

MR. J. F. ROSSMAN, president of the B-R Electric Company, Atlanta, Ga., was married to Miss Agnes Rose Lee, of Brooklyn, on September 16. Mr. Rossman has been identified with the street railways and electrical matters in Atlanta and the South.

MR. L. F. MAHLER, formerly assistant manager of the De Laval Steam Turbine Company, at Chicago, has taken charge of the St. Louis office of the Bullock Electric Manufacturing Company, with offices at 1505 Chemical Building, St. Louis.

PROFESSOR A. W. SMITH will soon take up his duties as head of the mechanical engineering department at Stanford University, California. Professor Smith has been spending the summer doing engineering work for Westinghouse, Church, Kerr & Company.

PROFESSOR W. KARAPETOFF, E. E., of St. Petersburg, in the employ of the Russian Government, taking a course at the Westinghouse works, has been commissioned by his government to inspect the South Pennsylvania Oil Company's electrical power plant at Folsom, W. Va.

PROFESSOR GEORGE H. ROWE, who has been appointed associate professor of electrical engineering at Stanford University, California, comes from the State University of Colorado, located at Boulder. Professor Rowe was the dean of the school of engineering and applied science at Boulder.

MR. JOHN W. FERGUSON, of the Chicago Edison Company, is to be further complimented for his excellent paper on "Tactful Relations with Customers," read before the last meeting of the National Electric Light Association. While the paper was addressed primarily to those concerned with electric lighting, it contained so many valuable suggestions of general application that the American Telephone and Telegraph Company has distributed copies of the paper among its employés in all parts of the country.

MR. F. A. BABCOCK is building a special electric automobile at the Buffalo Electric Carriage Works to undertake the feat of making the run from Boston to New York in an electric carriage. The distance is 235 miles in round numbers. Mr. Babcock stated that he expects to make the start from Boston on Friday, September 25. The vehicle will carry six people. It will have a speed of twenty-five miles an hour and its capacity will be seventy-five miles on one charge.

PROFESSOR C. P. MATTHEWS, associate professor of electrical engineering at Purdue University, has found it necessary to retire from active duty for a year owing to trouble with his eyes. Professor Matthews has carried on an extensive series of photometric tests and his reports to the National Electric Light Association have been widely quoted. Cornell University granted him a doctor's degree in recognition of his development of his integrating photometer. It is thought that constant work has overstrained his eyes. He has been granted a year's leave of absence by Purdue University.

PROFESSOR SAMUEL JACKSON BARNETT, of Stanford University, California, has returned after several months spent in survey work along the Alaskan coast. Professor Barnett made a special investigation of the peculiar magnetic disturbances which have made navigation difficult in certain localities. Near Skagway these disturbances are very severe, the deflection of the compass being so great that it is rendered almost useless in that vicinity. It was found that this strange state of affairs was due to an abundance of magnetic rock in the locality, which rock is present in enormous quantities at Douglas Island and on the mainland and near Skagway. Professor Barnett stated that there was an almost perfect magnetic pole at that point.

PROFESSOR A. SLABY, inventor of a system of wireless telegraph, was recently awarded a subsidy by the German Government of 200,000 marks to continue his experiments. The professor gives an account of the success of his latest experiments. In a statement he says in part: "It was until recently an open question whether the earth played any part in wireless telegraphy. To solve the question I had the floor of my laboratory covered with zinc, thereby making an artificial ground circuit, and have succeeded in proving that waves are transmitted not only through the air but through the earth as well. I have besides this been occupied in trying to simplify the instruments so that even a person without any scientific knowledge may measure the length of the waves transmitted and have succeeded in constructing a dozen different types which are all of great practical value."

MR. CYRUS O. BAKER, JR., of the firm of Baker & Company, 120 Liberty street, New York city, gold and platinum refiners, has recently completed an extensive trip abroad. Mr. Baker, who is the most prominent refiner of platinum in the United States, has many interests abroad, and during his trip visited England, France, Italy, Austria, Germany, Belgium and Russia. When asked for his opinion regarding the scarcity of supply of platinum, about which considerable outcry was raised a short time ago, Mr. Baker said:

"There is no doubt in my mind but that the cry of stringency is overdrawn. Of course, Russia continues to be the fountainhead of the supply of crude platinum. It is difficult to estimate the output, but as far as I can see there is not and there is not likely to be any dearth of supply. There are rumors, of course, at all times as to the French syndicate controlling the output of the mines, due to long contracts which have been made with the miners. As long as these conditions hold, I do not see the possibility of there being any reduction in prices. The Russians tell us that we can look for an increase in prices. The demand for platinum is increasing, the ratio of increase in the United States being greater than in any other country. It may be said, also, that the amount of platinum produced outside of Russian territory is far greater than ever before and appears to be increasing."

"During your trip did you notice any new methods of processing the platinum ores, and did you hear of any new extensive territories being opened?"

"No; there is nothing new in the way of processing. All the properties which I looked up are jogging along in the same old lines, and as far as there being any new territories opened, I have heard statements to the effect that there were extensive districts recently opened up in Russia, but these, I believe, are promulgated by stock-jobbing concerns, and in my mind there has not been any new territory opened up in some time."

Mr. Baker did not lose his genial heartiness during his trip abroad, and if extraneous appearances are any indication of good faith in the stability of the platinum market, he stands as a typical representative of unabated prosperity.

LEGAL NOTE.

AN INTERESTING SUIT AFFECTING CANADIAN ELECTRIC COMPANIES—The arbitrators in the case of the Consumers' Electric Company *vs.* the Ottawa Electric Company handed down their decision on August 10, which was in favor of the plaintiffs. At the time the city (Ottawa, Canada) council granted the Consumers' company permission to do business in the city it was stipulated with the agreement of the Ottawa Electric Company that the Consumers' company should be allowed to string wires on the rival company's poles on certain streets. The Ottawa Electric Company, however, afterward refused this permission on the ground that the stringing of the Consumers' wires on its poles would impair the efficiency of its service. The Consumers' company brought action against the Ottawa Electric Company in the high court.

TELEPHONE AND TELEGRAPH.

REINBECK, IOWA—A telephone exchange is to be established in this town.

NORFOLK, VA.—A charter has been granted to the Clinton & Garland Telephone Company.

ST. LOUIS, MO.—The Kinloch Telephone Company will construct a line from Alton to Springfield.

BURLINGTON, VT.—The New York & Northern Telephone and Telegraph Company has applied for a franchise.

COHOES, N. Y.—The Home Telephone Company will shortly commence the construction of a line to Crescent.

CANAJOHARIE, N. Y.—The capital stock of the Glen Telephone Company is to be increased from $100,000 to $300,000.

DEADWOOD, S. D.—The Nebraska Telephone Company has applied for a twenty-year franchise to operate in this city.

INDIANAPOLIS, IND.—E. M. Beekman and E. O. Woods have purchased the Van Buren telephone system from R. Lowe.

FLORENCE, ALA.—The new telephone system for Florence has been completed and is now in operation. It cost $9,000.

NEW BRITAIN, CT.—R. L. Andrews has been granted a franchise to establish a telephone line in Great Barrington, Mass.

SOUTH NORWALK, CT.—Arrangements are being made to extend the local telephone system to North Stamford and to Long Ridge.

TERRE HAUTE, IND.—A. A. Tibbe has sold the electric light and telephone system at Washington, Mo., to the firm of Hibbler & Earnst.

AUGUSTA, GA.—The Bell Telephone Company has begun operations on the construction of its long-distance line from Augusta to Lincolntown.

BALTIMORE, MD.—The Petersburg Telephone Company has completed a line to City Point, and that place is now in communication with Petersburg.

SALISBURY, MD.—The Diamond State Telephone Company is arranging to build a new line from Salisbury to Hurlock, *via* Hebron, Madela and Vienna.

HAWKINSVILLE, GA.—The Southern Bell Telephone Company has been given the right to extend its lines to Eastman, Cochran and Hawkinsville, from Macon.

PITTSBURG, PA.—It is stated that the management of the Erie Railroad has decided to equip the entire system with telephones, at an expense of nearly $1,000,000.

DOVER, DEL.—The Diamond State Telephone Company is making arrangements for a line from Salisbury to Hurlock, Md. Hebron, Mardela and Vienna are the towns on the proposed line.

FLORENCE, COL.—The Colorado Telephone Company has begun the work of stringing a new line between Florence and Canon City, and between this city and Cripple Creek.

GRAND RAPIDS, MICH.—The A. C. Himebaugh Telephone Company has changed its name to the Southern Michigan Telephone Company and increased its capital from $5,000 to $60,000.

COLUMBUS, GA.—The Adams telephone system, of Stewart County, has been extended to this city, a line being built through Russell County, Alabama, up the Chattahoochee River to Girard.

COLUMBIA CITY, IND.—At a recent meeting of the business men of this city, a farmers' telephone company was organized, to be known as the Farmers' Mutual Telephone Company, of Whitley County.

MARLBORO, MASS.—Arrangements are being made by the New England Telegraph and Telephone Company for a direct wire between Marlboro and Worcester, and the work of stringing the wire will begin at once.

CHATTANOOGA, TENN.—H. S. Chamberlain has been elected temporary chairman of the Hamilton Telephone Company, and E. Y. Chapin, secretary. The company will shortly install an independent service in this city.

MIFFLINSBURG, PA.—The Columbia County Telephone Company has been organized for the purpose of building a line for the exclusive use of farmers residing in the counties of Columbia, Montour, Lycoming, Luzerne and Sullivan.

WEST UNION, OHIO—The Adams County Telephone Company, of Peebles, has been incorporated at Columbus with a capital of $10,000. The incorporators are E. Humphrey, J. F. Platter, Dr. J. S. Berry, John Blair and Dr. G. F. Thomas.

WICHITA, KAN.—The Whitewater Telephone Company has been incorporated with a capital of $2,500. This company will establish an exchange in Whitewater, which will connect with the long-distance lines of the Wichita Telephone Company.

MILWAUKEE, WIS.—Articles of incorporation have been filed for the Knapp Telephone Company, Knapp, Dunn County, with a capital of $5,000. The incorporators are C. A. Silkworth, J. J. Osborn, of Eau Claire, and Charles Townsend and C. McV. Fletcher, of Knapp.

ST. LOUIS, MO.—It is stated that a project is under way for an independent telephone system for St. Louis County. A number of capitalists of the country are said to be interested, among them J. D. Houseman, J. B. Lucas, D. C. Taylor, F. A. Heidorn and Edward Miller.

AUSTIN, TEX.—The People's Home Telephone Company, of Gainesville, Denton and Mineral Wells, Tex., Wilkesbarre, Pa., and Chicago, has been organized with a capital of $250,000, for the purpose of constructing and operating telephone exchanges and long-distance lines.

GLOVERSVILLE, N. Y.—The board of trustees of Fonda has granted the Glen Telephone Company permission to set poles and string wires in the village. The company will in a short time combine its Fultonville business with the Fonda office and an all-night telephone service will be given.

ALBANY, N. Y.—The Earlville Telephone Company has been incorporated with a capital of $40,000, to operate in Madison, Chenango, Delaware, Otsego, Cortland, Oneida, Broome, Onondaga and Oswego counties. The directors of the company are Parker Newton, Guy C. Clark, Clayton I. Burch and Avery M. Hoadley.

DETROIT, MICH.—The plant of the People's Telephone Company, representing an investment of approximately $400,000, has been sold to a syndicate now operating independent telephone systems throughout the country. The company has petitioned the common council for a new franchise to operate lines in the city and connect with independent telephone lines throughout the state.

MINNEAPOLIS, MINN.—The amount of indebtedness to which the Northwestern Telephone Company may be liable has been increased from $2,000,000 to $4,000,000. The company will spend $800,000 in improvements during the present year, consisting of extended toll lines, better equipment wherever possible, improved service in this city, and the erection of a new addition to its east station.

KANSAS CITY, MO.—Fire in the five-story telephone building in this city burned all the toll boards and damaged the main switchboard so that for at least thirty days, and probably for some time, there will be no telephone service in the business district, and no toll or long-distance service between Kansas City and any outside point. The loss on the building and apparatus will be about $150,000, fully covered by insurance. The origin of the fire is unknown.

TRENTON, N. J.—Articles have been filed with the secretary of state, merging the American Telephone and Telegraph Company of New Jersey, the New York & Philadelphia Telephone and Telegraph Company and the Midland Telephone and Telegraph Company into the American Telephone and Telegraph Company of New Jersey. The new company has an authorized capital of $130,000, and is a long-distance branch of the Bell telephone system. The officers are Edward J. Holl, Morris Township, N. J., president; Edward P. Meaney, Newark, vice-president; Melville Egleston, Elizabeth, secretary; James P. Vail, New York, treasurer.

INDUSTRIAL ITEMS.

NERNST LAMP COMPANY, New York, announces the removal of its office from the Equitable Building to the New Hanover Bank Building, 11 Pine street.

CROCKER-WHEELER COMPANY, Ampere, N. J., has issued a very attractive bulletin showing a Crocker-Wheeler railway generator, which will be sent upon request.

MOHAWK AUTOMOBILE COMPANY, Detroit, Mich., is about to have an immense factory erected. The company was recently incorporated with a capital of $400,000.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD COMPANY is having installed at Carman, N. Y., an automatic electric system of signals at an expense of $25,000.

THE GREENFIELD ELECTRIC LIGHT AND POWER COMPANY, Greenfield, Mass., has petitioned for leave to issue $100,000 of bonds, $75,000 of which will be for a dam and power plant on the Dearfield river.

SARGENT, CONANT & COMPANY, Boston, Mass., have recently completed the installation of an electric lighting and power system for the town of Groton, Ct., and will shortly begin work on a similar equipment for the town of Millers Falls, Mass.

WESTINGHOUSE MACHINE COMPANY, Pittsburg, Pa., recently secured an order for the largest turbo-generators in the world, which are to be installed at the Long Island City powerhouse of the new Pennsylvania terminal, and will consist of three 5,500-kilowatt turbo-generator units.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has recently established an agency for the sale of Nernst lamps and supplies with the W. G. Nagel Company, Toledo, Ohio. The W. G. Nagel Company, for several years past, has acted as selling agent for the Westinghouse Electric and Manufacturing Company.

THE OSBURN-MORGAN COMPANY, Cleveland, Ohio, has entered into negotiations with the Crouse-Hinds Company, Syracuse, N. Y., to take over the sole patents and rights of the Osburn-Morgan Company's arc lamp department. The matter is not at present consummated, and a further statement will be made by the company at a later date.

THE L. B. ALLEN COMPANY, Inc., Chicago, Ill., is distributing some attractive literature descriptive of its several specialties. This consists of soldering sticks, pastes or salts, and commutator compound. The Allen soldering stick is popular for many forms of work. This is a soldering agent put up in round sticks, six inches long and one inch in diameter.

THE BOARD OF PUBLIC WORKS, Seattle, Wash., has let part of the contracts for the proposed municipal power plant as follows: Wiring cable, Standard Underground Cable Company, Pittsburg, Pa., amounting to approximately $29,856; water-wheels and equipments, Pelton Water-Wheel Company, New York, amounting to approximately $13,080; 250 tons, forty-eight-inch steel pipe, T. A. Gillespie & Company, Pittsburg, Pa., amounting to approximately $14,098.

THE MONASH-YOUNKER COMPANY, 43 Centre street, New York city, and 207 South Canal street, Chicago, is manufacturing the Monash automatic air valve for steam radiators, for which the manufacturer claims several excellent characteristics. It prevents flooding of floors, it has no cap to be lost and there are no screws exposed. The company states that these automatic air valves are in use in over 55,800 buildings in this and foreign countries. A card descriptive of the Monash steam trap for high or low pressure will be sent on request.

THE THOMAS E. CLARK WIRELESS TELEGRAPH-TELEPHONE COMPANY, Detroit, Mich., gave a practical demonstration of the commercial availability of its system at the Michigan State Fair, recently held at the city of Pontiac. A number of stations was located on the grounds, in charge of the company's operators, who were kept busy sending and receiving over 3,000 messages to private parties, heads of departments, officers, judges of the fair and city officials. The "Junior" type Clark instruments, operated with dry batteries, were used. The company states that a high efficiency of operation and positive accuracy were secured.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, gave its annual field day to its employés at Silver Lake, thirty-five miles south of Cleveland, Ohio, on Saturday, September 12. An elaborate programme of field sports was indulged in, for which valuable prizes were given. Two baseball teams, composed of employés of the North Electric Company, contested for the valuable silver cup which is a permanent challenge trophy and is played for by these teams each year. The party went to and returned from Silver Lake in a special train of ten coaches. Mr. F. F. Sapp, manager of the sales department, was the official starter.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, through its eastern district office, Philadelphia, Pa., reports recent sales as follows: Dallas, Pa., 209-line switchboard and telephones; Tunkhannock, Pa., 100-line switchboard and telephones; New Albany, Pa., 25-line switchboard and telephones; Waterside, Pa., 25-line switchboard and telephones; Alexandria, Va., 350-line switchboard and telephones; Perth Amboy, N. J., 150-line switchboard and telephones; Lambertville, N. J., 150-line switchboard and telephones; Flemington, N. J., 150-line switchboard and telephones; New Egypt, N. J., 100-line switchboard and telephones; New Lisbon, N. J., 100-line switchboard and telephones. In addition to the foregoing list of sales, the company has just received orders for substantial additions to the "Main" and "Race" Exchanges of the Keystone Telephone Company in Philadelphia, amounting to five sections for each exchange, making the total present equipment of each of the above exchanges 5,200 lines. Mr. Paul W. Bossart is manager of the eastern district office of the Kellogg Switchboard and Supply Company.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed contracts for the installation of batteries of chloride accumulator for the Indianapolis & Northern Railway, of Sulphur Springs, Ind., making seven batteries operated by this company at Broad Ripple; an increase in the two batteries recently installed for the Los Angeles Railway Company, Los Angeles, Cal.; and an installation for the Northwestern Elevated Railway, of Chicago, Ill. Four new batteries have been contracted for by the Chicago Edison Company, making thirteen batteries operated by this company. An installation has been contracted for for the Paterson Edison Company, Paterson, N. J., also a second battery for the Los Angeles Edison Company, Los Angeles, Cal., and an additional battery for the New York Edison Company, which makes twenty-two batteries operated by this company. Isolated lighting and power plants are being installed for the Murphy Building and for William P. Stevenson, Detroit, Mich.; Alexander Winton, Cleveland, Ohio; F. T. F. Lovejoy, Pittsburg, Pa.; the House of the Good Shepherd, Roxbury, Mass., and for the Irving Building, Louisville, Ky.

LOOSE-WILES CRACKER AND CANDY COMPANY, Kansas City, Mo., has recently completed the construction of a new factory located at Eighth, Santa Fe and Henning streets. The new building is of modern mill construction and is 184 feet long by 128 feet in width and consists of six stories and basement. The power equipment of this factory embraces one seventy-five-kilowatt and one 100-kilowatt Westinghouse generators, connected to straight line high-speed engines. There are also a number of Westinghouse motors in use in this establishment. The current which is supplied to these motors at 110 volts is conveyed from the switchboard by means of rubber-covered cables, the power is economically distributed, a submotor being provided for each department. All motors are suspended from the ceiling and are connected to the machinery by belts. The switchboard apparatus is also supplied by the Westinghouse company. Connections between the switchboard and generators are such as to allow the operation of either generator for power or lighting exclusively or both generators may be used for lighting and power at the same time. The boiler plant consists of six tubular boilers, each sixty inches in diameter by sixteen feet long. These boilers are equipped with Roney mechanical stokers.